2006 ENGINE

Engine Electrical - Lucerne

SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

Fastener Tightening Specifications

Application	Specification	
	Metric	English
Battery Hold Down Bolt	17 N.m	13 lb ft
Engine Ground Cable to Right Side Body Frame Rail (PRO LD8)	25 N.m	18 lb ft
Generator Bolt/Stud	50 N.m	37 lb ft
Generator Brace Bolt (RPO L26)	25 N.m	18 lb ft
Generator Brace Nut (RPO L26)	50 N.m	37 lb ft
Generator Terminal Nut (RPO L26)	20 N.m	15 lb ft
Generator Terminal Nut (RPO LD8)	12 N.m	106 lb in
Ignition Control Module (ICM) Ground Strap to Camshaft Cover Bolt (RPO LD8)	10 N.m	89 lb in
Ignition Control Module (ICM) Ground Strap to Left Cylinder Head Bolt (RPO LD8)	25 N.m	18 lb ft
Ignition Control Module (ICM) Ground Strap to Right Cylinder Head Bolt (RPO LD8)	10 N.m	89 lb in
Negative Battery Cable Bolt	17 N.m	13 lb ft
Negative Battery Cable Ground Bolt	36 N.m	27 lb ft
Positive Battery Cable Bolt	17 N.m	13 lb ft
Positive Battery Cable to Junction Block Nut	15 N.m	11 lb ft
Starter Cable Ground to Engine Bolt (RPO L26)	25 N.m	18 lb ft
Starter Cable to Side Rail Bolt (RPO L26)	20 N.m	15 lb ft
Starter Motor Bolt (RPO L26)	43 N.m	32 lb ft
Starter Motor Bolt (RPO LD8)	25 N.m	18 lb ft
Starter Solenoid "BAT" Terminal Nut	10 N.m	89 lb in
Starter Solenoid Cable to Bussed Electrical Center (BEC) Nut	15 N.m	11 lb ft
Starter Solenoid "S" Terminal Nut (RPO L26)	2.3 N.m	20.5 lb in
Starter Solenoid "S" Terminal Nut (RPO LD8)	4 N.m	35 lb in
Transaxle Cover Bolt (RPO L26)	7.5 N.m	66 lb in

BATTERY USAGE

Battery Usage

Application	Specification
Cold Cranking Amperage (CCA)	880 A
Reserve Capacity	140 Minutes
Replacement Model Number	79-6YR

GENERATOR USAGE

Generator Usage

Application 4.6 L	Specification
Generator Model	SC2
Rated Output	150 Amps
Load Test Output	105 Amps

Generator Usage

Application 3.8 L	Specification
Generator Model	SC1
Rated Output	135 Amps
Load Test Output	85 Amps

SCHEMATIC AND ROUTING DIAGRAMS

STARTING AND CHARGING SCHEMATICS

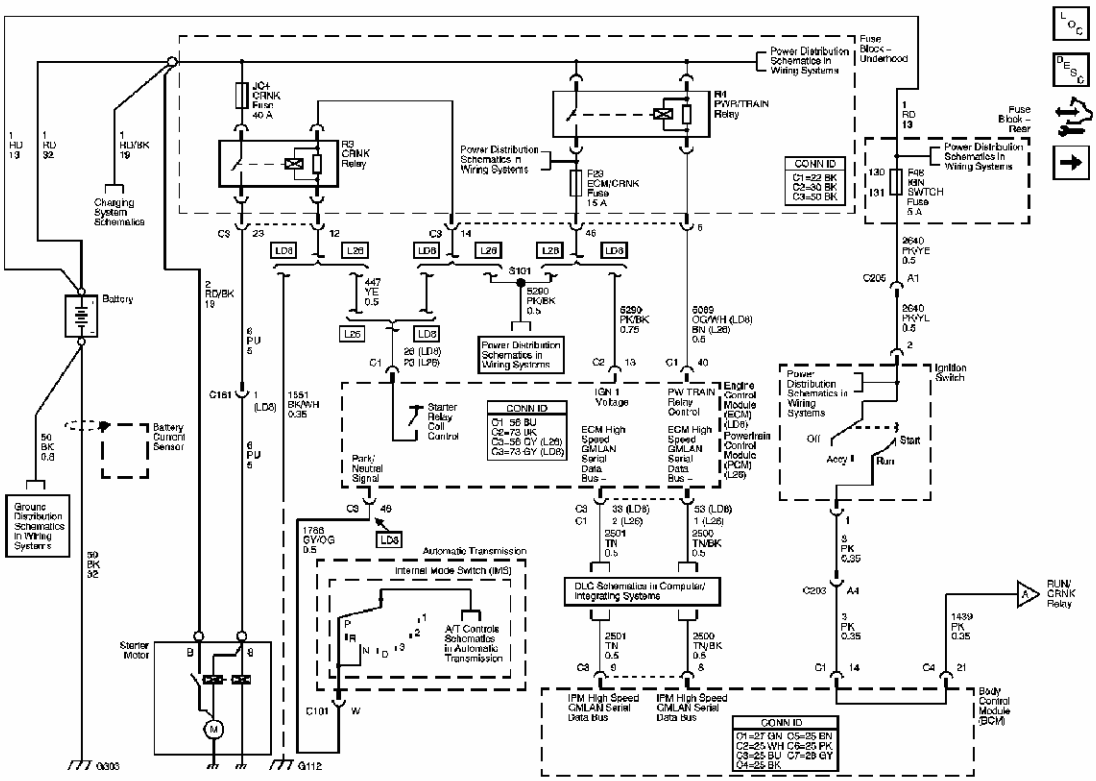


Fig. 1: Starting Schematic (1 of 2)
Courtesy of GENERAL MOTORS CORP.

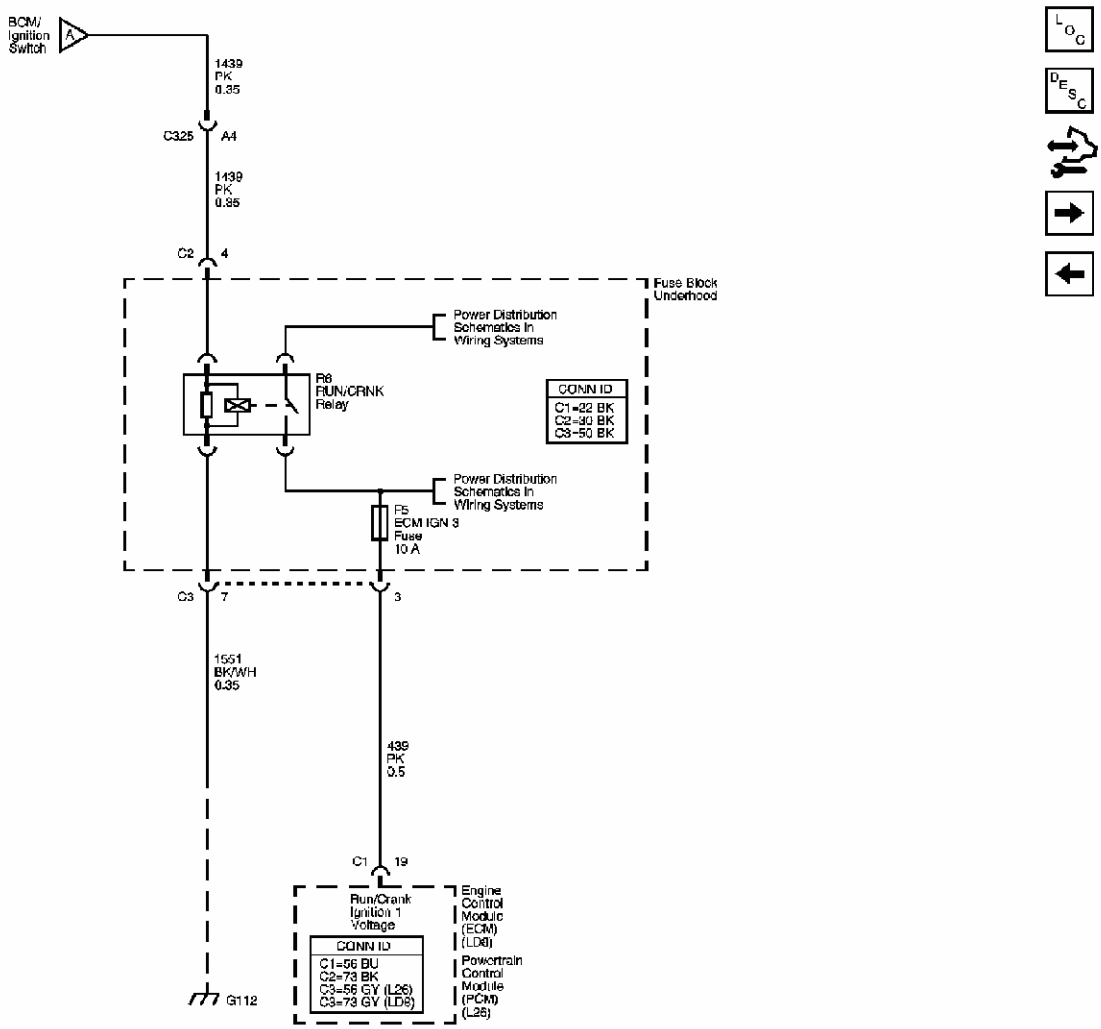


Fig. 2: Starting Schematic (2 of 2)
Courtesy of GENERAL MOTORS CORP.

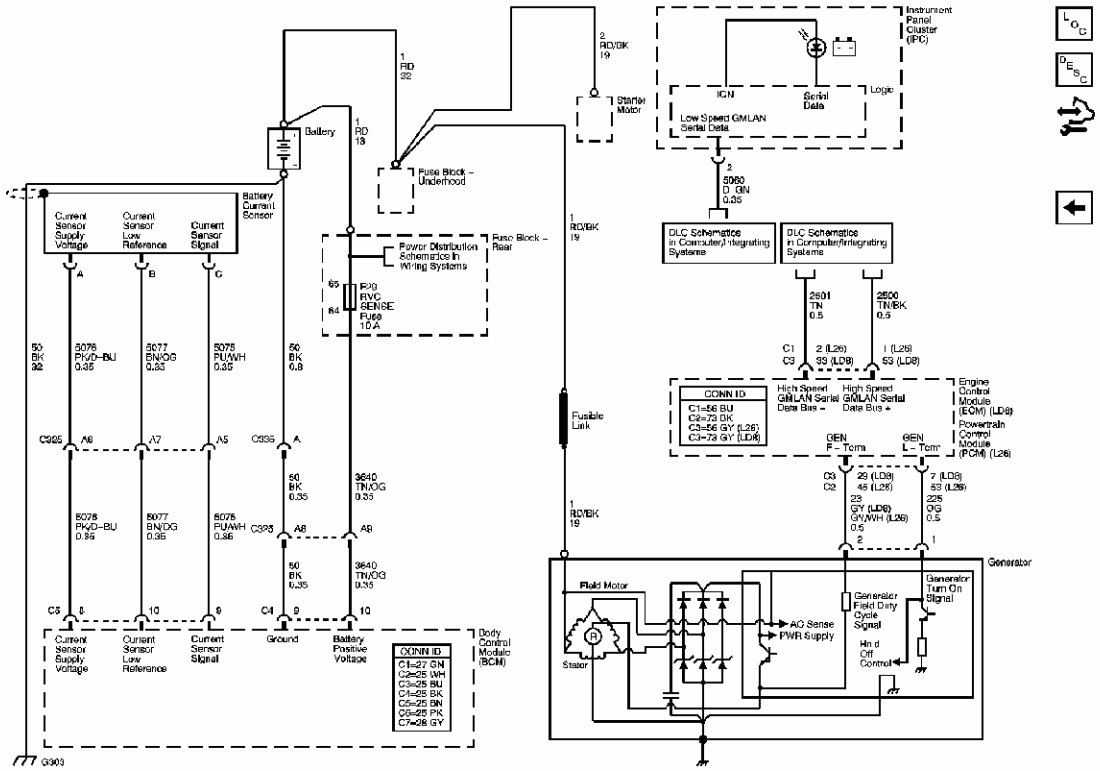


Fig. 3: Charging Schematic
Courtesy of GENERAL MOTORS CORP.

COMPONENT LOCATOR

ENGINE ELECTRICAL COMPONENT VIEWS

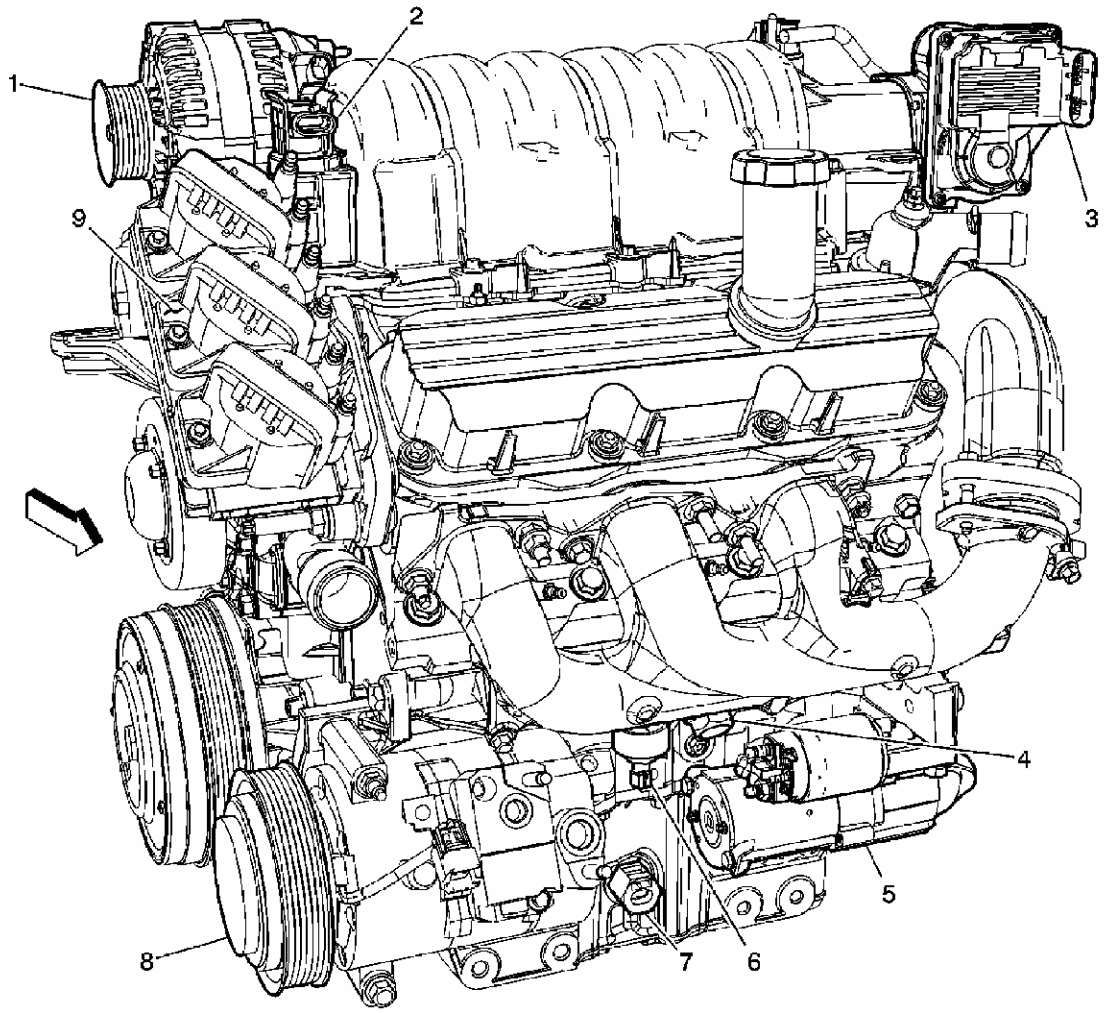


Fig. 4: View Of Front Of Engine (L26)
Courtesy of GENERAL MOTORS CORP.

Callouts For Fig. 4

Callout	Component Name
1	Generator
2	Manifold Absolute Pressure (MAP) Sensor
3	Throttle Actuator Control (TAC) Module
4	Engine Coolant Heater
5	Starter
6	Knock Sensor (KS) 1
7	Engine Oil Level Switch
8	A/C Compressor Clutch
9	Ignition Control Module (ICM)

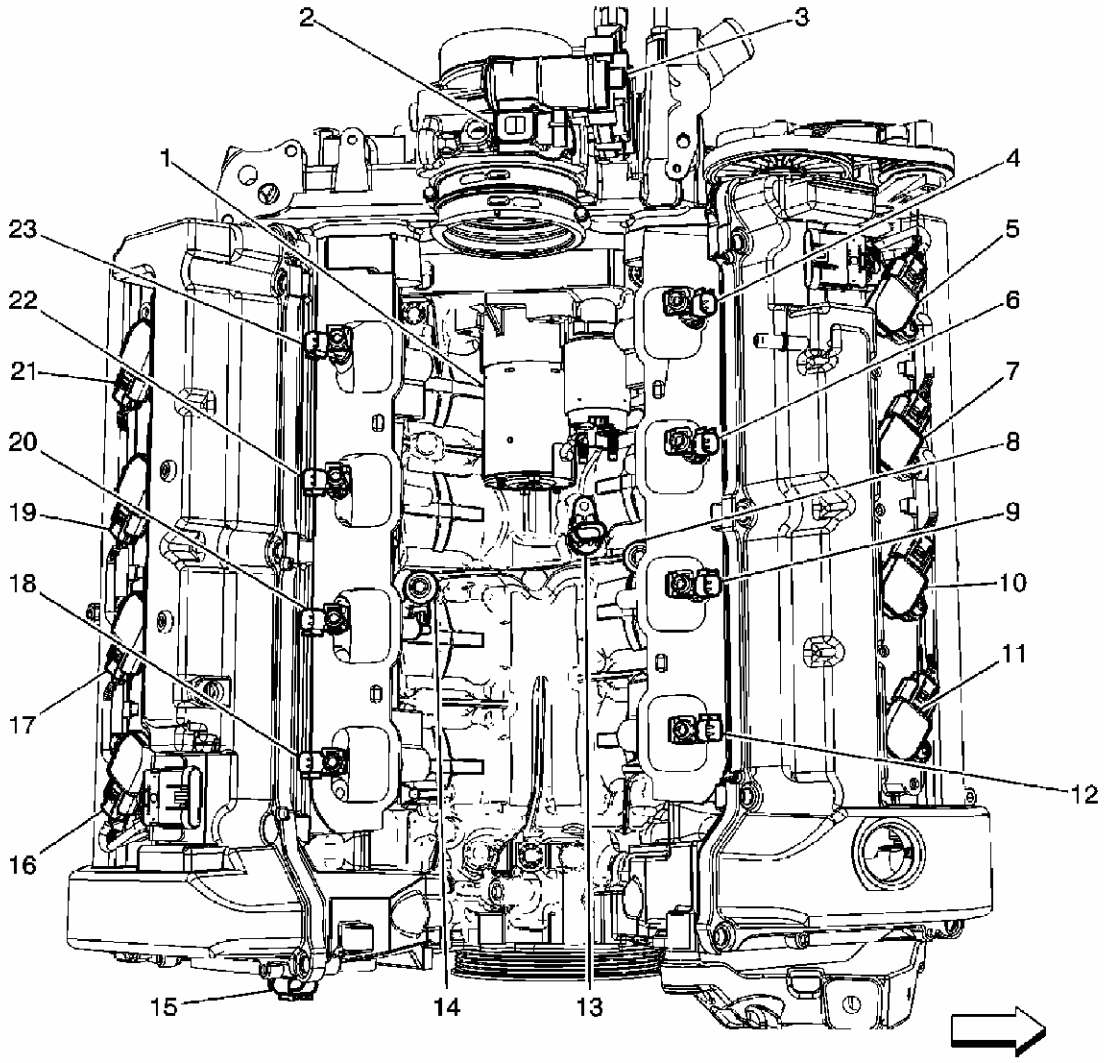


Fig. 5: View Of Top Of Engine (L37/LD8)
Courtesy of GENERAL MOTORS CORP.

Callouts For Fig. 5

Callout	Component Name
1	Starter
2	Manifold Absolute Pressure (MAP) Sensor
3	Throttle Body Assembly
4	Fuel Injector 8
5	Ignition Coil/Module 8
6	Fuel Injector 6
7	Ignition Coil/Module 6
8	Knock Sensor (KS) 2
9	Fuel Injector 4
10	Ignition Coil/Module 4

16	Ignition Coil/Module 2
17	Fuel Injector 6
18	Crankshaft Position (CKP) Sensor
19	Fuel Injector 4
20	Camshaft Position (CMP) Sensor
16	Ignition Coil/Module 1
17	Ignition Coil/Module 3
18	Fuel Injector 1
19	Ignition Coil/Module 5
20	Fuel Injector 3
21	Ignition Coil/Module 7
22	Fuel Injector 5
23	Fuel Injector 7

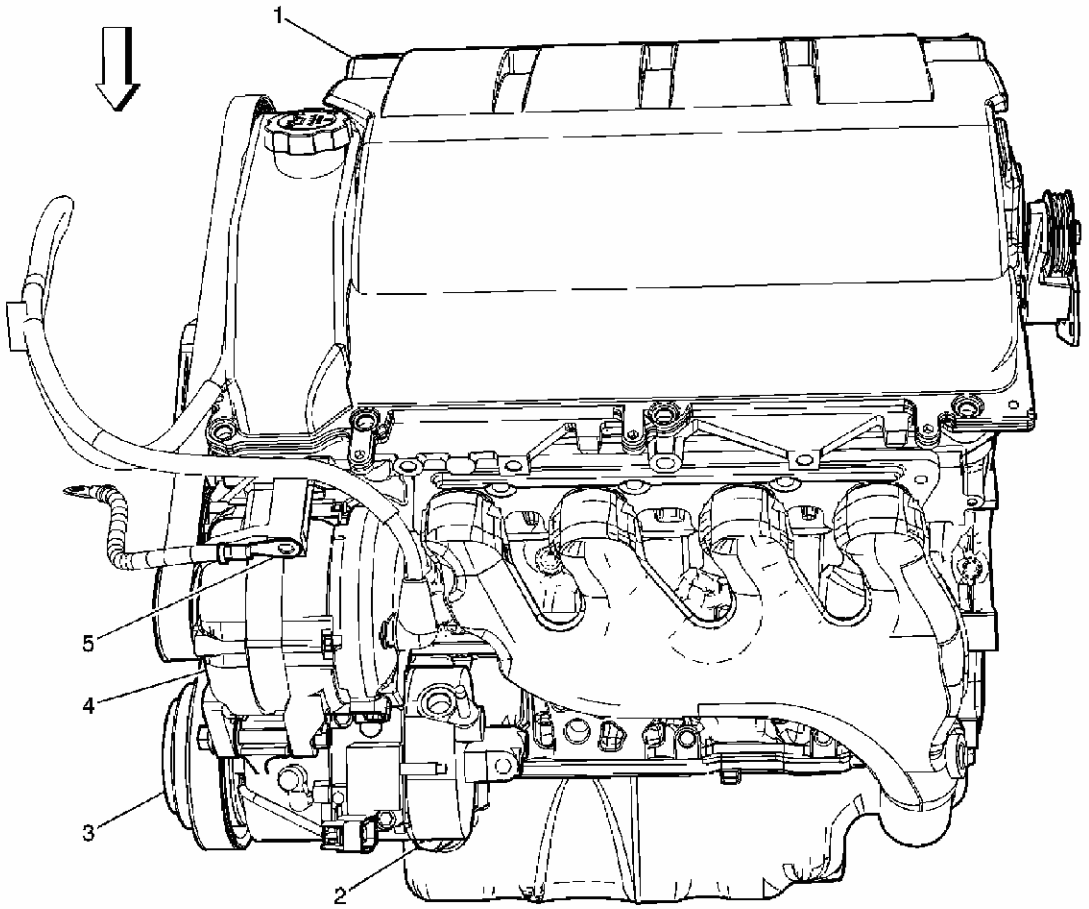


Fig. 6: View Of Left Side Of Engine (4.6L)
Courtesy of GENERAL MOTORS CORP.

Callouts For Fig. 6

Callout	Component Name
1	Engine - 4.6L
2	Engine Oil Level Switch (06)
3	A/C Compressor
4	Generator
5	G110

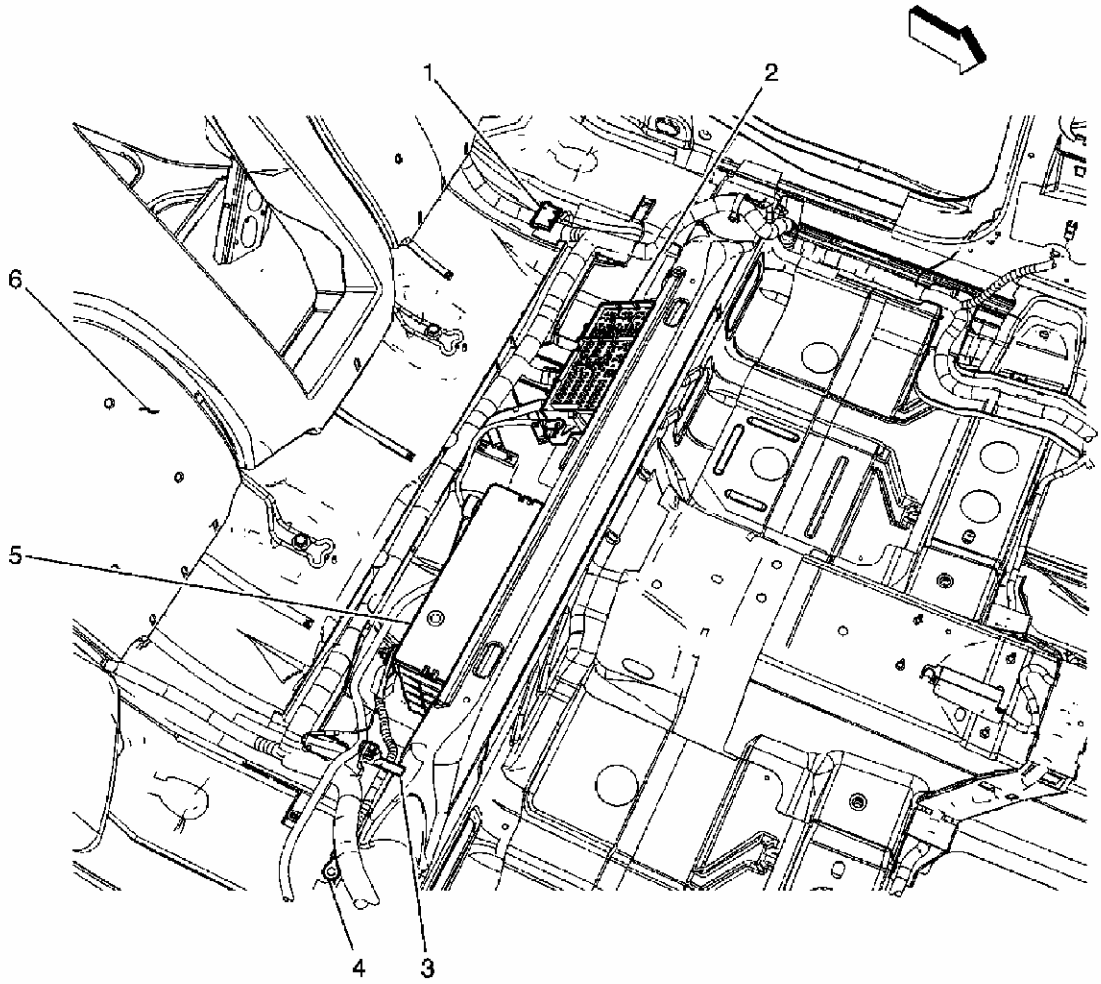


Fig. 7: View Under Rear Seat
Courtesy of GENERAL MOTORS CORP.

Callouts For Fig. 7

Callout	Component Name
1	SP300
2	Fuse Block - Rear
3	Battery Current Sensor

Callout	Component Name
1	G303 Battery
2	Rear Seat

ENGINE ELECTRICAL CONNECTOR END VIEWS

Battery Current Sensor

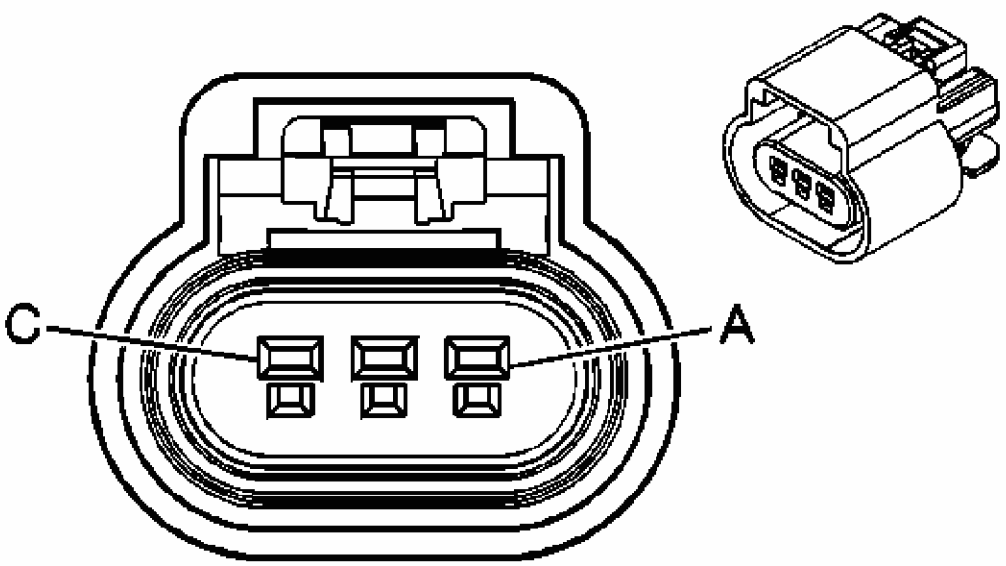


Fig. 8: Battery Current Sensor Connector End Views
Courtesy of GENERAL MOTORS CORP.

Engine Electrical Connector End Views

Connector Part Information

- OEM: 15326808
- Service: See Catalog
- Description: 3-Way F GT 150 Series Sealed 4.5 (BK)

Terminal Part Information

- Terminal/Tray: 12191819/8
- Core/Insulation Crimp: E/A
- Release Tool/Test Probe: 15315247/J-35616-2A (GY)

Battery Current Sensor

Pin	Wire Color	Circuit No.	Function
A	PK/D-BU	5076	Current Sensor Supply Voltage
B	BN/OG	5077	Current Sensor Low Reference
C	PU/WH	5075	Current Sensor Signal

Generator

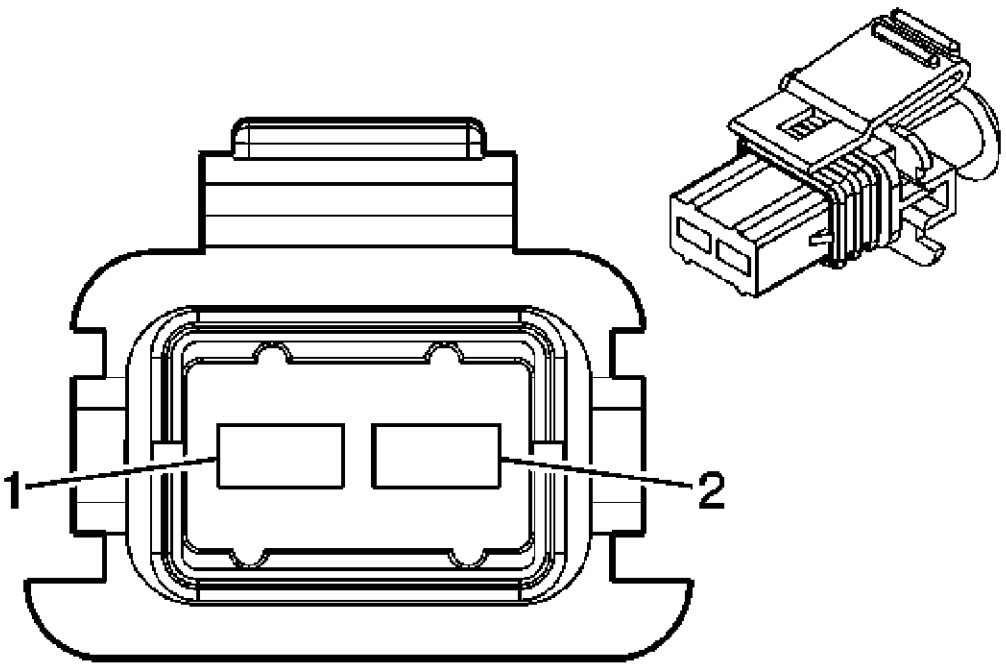


Fig. 9: Generator Connector End View
Courtesy of GENERAL MOTORS CORP.

Engine Electrical Connector End Views

Connector Part Information

- OEM: 12186308
- Service: 89046837
- Description: 2-Way F JPT, Sealed (BK)

Terminal Part Information

- Terminal/Tray: 4-964286-1/16

Connector Part Information

- Core/Insulation Crimp: E/1
- Release Tool/Test Probe: 12093647/J-35616-4A (PU)
- OEM: 15186308

Generator

Pin	Wire Color	Circuit No.	Function
1	OG	225	Generator Turn On Signal
2	GY/WH	23	Generator Field Duty Cycle Signal (L26)
2	GY	23	Generator Field Duty Cycle Signal (LD8)

DIAGNOSTIC INFORMATION AND PROCEDURES

DIAGNOSTIC CODE INDEX

DIAGNOSTIC CODE INDEX

DTC	Description
DTC B1325	Device Power Circuit
DTC B1405	** DESCRIPTION NOT COLLECTED **
DTC B1424	**DESCRIPTION NOT COLLECTED **
DTC B1516	**DESCRIPTION NOT COLLECTED **
DTC B1517	Battery Voltage
DTC B1527	**DESCRIPTION NOT COLLECTED **
DTC P0560	System Voltage
DTC P0562	**DESCRIPTION NOT COLLECTED **
DTC P0563	**DESCRIPTION NOT COLLECTED **
DTC P0615 (3.8L)	DTC P0615 Starter Relay Control Circuit
DTC P0615 (4.6L)	DTC P0615 Starter Relay Control Circuit
DTC P0621	**DESCRIPTION NOT COLLECTED **
DTC P0622 (Gas)	**DESCRIPTION NOT COLLECTED **
DTC P1668	**DESCRIPTION NOT COLLECTED **

DIAGNOSTIC STARTING POINT - ENGINE ELECTRICAL

Begin the system diagnosis with the **Diagnostic System Check - Vehicle** . The Diagnostic System Check will provide the following information:

- The identification of the control modules which command the system
- The ability of the control modules to communicate through the serial data circuit
- The identification of any stored diagnostic trouble codes (DTCs) and their status

The use of the Diagnostic System Check will identify the correct procedure for diagnosing the system and where the procedure is located.

SCAN TOOL OUTPUT CONTROLS

Scan Tool Output Controls

Scan Tool Output Control	Additional Menu Selection(s)	Description 3.8L/4.6L
Engine Output Controls	GEN L-Terminal	The engine control module (ECM)/powertrain control module (PCM) commands the generator OFF by removing the 5-volt reference signal from the L terminal of the voltage regulator when you select Off. The generator will then stop generating an output voltage.

Scan Tool Output Controls

Scan Tool Output Control	Additional Menu Selection(s)	Description 4.6L
Engine Output Controls	Starter Relay Control	The engine control module (ECM) commands the Crank Relay OFF by removing the 12 volts from the control circuit of the Crank Relay when you select OFF. Voltage will then stop flowing through the switch of the Crank Relay.

SCAN TOOL DATA LIST

Amplifier (AMP)

Scan Tool Parameter	Data List	Units Displayed	Typical Data Value
Operating Conditions: Ignition ON/Engine Running			
Battery Voltage	Data Display	Volts	13.9 Volts

Body Control Module (BCM)

Scan Tool Parameter	Data List	Units Displayed	Typical Data Value
Operating Conditions: Ignition ON/Engine Running			
Battery Low at Start	Data Display/Charging Info	Yes/No	No
Batt. Open Ckt. Tested	Data Display/Charging Info	Yes/No	No

Scan Tool Parameter	Data List	Units Displayed	Typical Data Value
Batt. Voltage	Data Display/Charging Info	Volts	13.03 Volts
Battery Voltage	Data Display/Charging Info	Volts	13.9 Volts
Batt. Voltage High Res.	Data Display/Charging Info	Volts	12.417 Volts
Parasitic Current	Data Display/Charging Info	Amps	0.0 Amps
Prev. State of Charge	Data Display/Charging Info	%	90%
Start Up State of Charge	Data Display/Charging Info	%	80%
State of Charge	Data Display/Charging Info	%	85%
State of Charge Low	Data Display/Charging Info	Yes/No	No

Digital Radio Receiver (DRR)

Scan Tool Parameter	Data List	Units Displayed	Typical Data Value
Operating Conditions: Ignition ON/Engine Running			
Battery Voltage	Data Display	Volts	13.9 Volts

Driver Door Switch

Scan Tool Parameter	Data List	Units Displayed	Typical Data Value
Operating Conditions: Ignition ON/Engine Running			
Battery Voltage Signal	Data Display	Volts	13.9 Volts

Driver Door Module

Scan Tool Parameter	Data List	Units Displayed	Typical Data Value
Operating Conditions: Ignition ON/Engine Running			

Battery Voltage	Data Display	Volts	13.9 Volts

Engine Control Module (ECM)

Scan Tool Parameter	Data List	Units Displayed	Typical Data Value
Operating Conditions: Ignition ON/Engine OFF			
Crank Request Signal	Engine Electrical	Yes/No	No
GEN F-Terminal Signal	Engine Electrical	%	0%
GEN L-Terminal Command	Engine Electrical	%	0%
GEN L-Terminal Circuit Status	Engine Electrical	Incomplete/Short Gnd/Open/Short to B+/OK	OK
Ignition 1 Signal	Engine Electrical	Volts	Varies
Ignition Accessory Signal	Engine Electrical	On/Off	On
PNP Switch	Engine Electrical	Park/Neutral/In Gear	Park
Starter Relay Command	Engine Electrical	On/Off	Off
Starter Relay Circuit Status	Engine Electrical	Incomplete/Short Gnd/Open/Short to B+/OK	OK

Instrument Panel Cluster (IPC)

Scan Tool Parameter	Data List	Units Displayed	Typical Data Value
Operating Conditions: Ignition ON/Engine Running			
Battery Voltage	Data Display	Volts	13.9 Volts

Left Rear Door Module

Scan Tool Parameter	Data List	Units Displayed	Typical Data Value
Operating Conditions: Ignition ON/Engine Running			
Battery Voltage	Data Display	Volts	13.9 Volts

Memory Seat Module (MSM)

Scan Tool Parameter	Data List	Units Displayed	Typical Data Value
Operating Conditions: Ignition ON/Engine Running			
Battery Voltage	Data Display	Volts	13.9 Volts

Powertrain Control Module (PCM)

Scan Tool Parameter	Data List	Units Displayed	Typical Data Value
Operating Conditions: Ignition ON/Engine OFF			
Crank Request Signal	Engine Electrical	Yes/No	No
GEN F-Terminal Signal	Engine Electrical	%	0%
GEN L-Terminal Signal Command	Engine Electrical	On/Off	Off
Generator Lamp Command	Engine Electrical	On/Off	On
Ignition 1 Signal	Engine Electrical	Volts	Varies
IMS	Engine Electrical	Park, Park/Reverse, Reverse, Reverse/Neutral, Neutral, Neutral/Drive 4, Drive 4, Drive 4/Drive 3, Drive 3, Drive 3/Drive 2, Drive 2, Drive 2/Drive 1, Drive 1, INVALID, OPEN	Park
Starter Relay Command	Engine Electrical	On/Off	Off
Starter Relay Circuit History	Engine Electrical	OK/Open/Short/Invalid State	OK

Right Rear Door Module

Scan Tool Parameter	Data List	Units Displayed	Typical Data Value
Operating Conditions: Ignition ON/Engine Running			
Battery Voltage	Data Display	Volts	13.9 Volts

Vehicle Theft Deterrent (VTD)

Scan Tool Parameter	Data List	Units Displayed	Typical Data Value
Operating Conditions: Ignition Cranking			
Battery Voltage	Data Display	Volts	12.0 Volts
Start Disabled	Data Display	Yes/No	Yes

Passenger Door Switch

Scan Tool Parameter	Data List	Units Displayed	Typical Data Value

Operating Conditions: Ignition ON/Engine Running			
Battery Voltage Signal	Data Display	Volts	13.9 Volts

Sensing Diagnostic Module (SDM)

Scan Tool Parameter	Data List	Units Displayed	Typical Data Value
Operating Conditions: Ignition ON/Engine Running			
Battery Voltage Signal	Data Display	Volts	13.9 Volts

Transmission Control Module (TCM)

Scan Tool Parameter	Data List	Units Displayed	Typical Data Value
Operating Conditions: Ignition ON/Transmission in Park			
IMS	Engine Electrical	Park, Park/Reverse, Reverse, Reverse/Neutral, Neutral, Neutral/Drive 4, Drive 4, Drive 4/Drive 3, Drive 3, Drive 3/Drive 2, Drive 2, Drive 2/Drive 1, Drive 1, INVALID, OPEN	Park

SCAN TOOL DATA DEFINITIONS

Battery Voltage

The scan tool displays 0-20 Volts. The scan tool displays the voltage as received by the Module.

Battery Voltage Signal

The scan tool displays 0-20 Volts. The scan tool displays the voltage as received by the Module.

Crank Request Signal

The scan tool displays Yes/No. The scan tool displays No until the ignition is placed into the START position then Yes is displayed.

GEN F-Terminal Signal

The scan tool displays 0-100%. The scan tool displays 0-100% until the engine is started and the engine control module (ECM) receives a signal from the generator then OK is displayed.

GEN L-Terminal Command

The scan tool displays 0-100%. The scan tool displays the percentage of the output voltage of the generator.

GEN L-Terminal Circuit Status

The scan tool displays Incomplete, Short Gnd/Open, Short to B+ or OK. The scan tool displays the status of the GEN-L Terminal circuit.

Ignition 1 Signal

The scan tool displays 0-20 Volts. The scan tool displays the voltage as received on the Ignition 1 circuit to the module.

Ignition Accessory Signal

The scan tool displays ON/OFF. The scan tool displays if the ignition 0 signal is On or OFF.

Ignition Voltage Signal

The scan tool displays Present/Not Present. The scan tool displays the status of the ignition voltage signal on the theft deterrent module (TDM).

PNP Switch (If Equipped)

The scan tool displays Park/Neutral or In Gear. The scan tool displays the position of the transmission setting.

Start Disabled

The scan tool displays YES/NO. The scan tool displays YES if the TDM has disabled the starting function.

Starter Relay Command

The scan tool displays ON/OFF. The scan tool displays Off until the ignition is placed into the CRANK position, then it reads On.

Starter Relay Circuit Status

The scan tool displays Incomplete, Short Gnd/Open, Short to B+ or OK. The scan tool displays the status of the STRTR relay.

Start Up State of Charge

The scan tool displays 1-100%. The scan tool displays the state of charge at initial key up.

Prev. State of Charge

The scan tool displays 0-100%. The scan tool displays the state of charge from the previous ignition cycle.

State of Charge

The scan tool displays 0-100%. The scan tool displays the present state of charge.

State of Charge Low

The scan tool displays YES/NO. The scan tool displays YES if the present state of charge is low.

DTC B1325

Circuit Description

The control modules on this vehicle monitor the battery voltage through the battery positive voltage circuits. This vehicle has multiple modules that will set this DTC. For more information on which modules, Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC B1325 Device Power Circuit

This vehicle has DTCs which include DTC Symptoms. For more information on DTC Symptoms, refer to **DTC Symptom Description** .

DTC B1325

DTC Symptom	DTC Symptom Descriptor
03	Voltage Below Threshold
07	Voltage Above Threshold

Conditions for Running the DTC

The voltage supplied to the control modules are in the range of 7-26 volts.

Conditions for Setting the DTC

B1325 03

- The control module detects a system voltage below the calibrated value usually 9 volts.
- The above condition is present at least 5 seconds.

B1325 07

- The control module detects a system voltage above the calibrated value usually 18 volts.
- The above condition is present at least 5 seconds.

Action Taken When the DTC Sets

- The control module immediately disables all outputs when a out of range voltage condition has been detected, with the exception of GMLAN and Run/Crank relay that are disabled after a 3 minute delay.
- The setting of other DTCs is inhibited.

Conditions for Clearing the DTC

- A current DTC clears when the malfunction is no longer present.
- A history DTC clears when the module ignition cycle counter reaches the reset threshold, without a repeat of the malfunction.

DTC B1325

Step	Action	Values	Yes	No
Schematic Reference: Control Module References				
1	Did you perform the Diagnostic System Check - Vehicle?	-	Go to **Step 2**	Go to **Diagnostic System Check - Vehicle**
2	1. Install a scan tool. 2. Turn ON the ignition, with the engine OFF. 3. With a scan tool, observe the Battery Voltage Signal parameter in the data list of the module setting the DTC	9-18 V		

3	Is the Battery Voltage Signal parameter displayed in the specified range? Is the DTC set as a current DTC?	-	Go to **Step 3** Go to **Step 7**	Go to **Step 4** Go to **Testing for Intermittent Conditions and Poor Connections**
4	1. Disconnect the harness connector of the module setting the DTC. 2. Measure the voltage between the battery positive voltage circuit at the module harness connector and a good ground. Is the measured value in the specified range?	9-18 V	Go to **Step 6**	Go to **Step 5**
5	Test the battery positive voltage circuit for the following: • A short to ground • An open • A high resistance Refer to **Circuit Testing** and **Wiring Repairs** . Did you find and correct the condition?	-	Go to **Step 9**	Go to **Charging System Test**
6	Test the all of ground circuits of the module for an open or high resistance. Refer to **Circuit Testing** and **Wiring Repairs** . Did you find and correct the condition?	-	Go to **Step 9**	Go to **Step 7**
7	Inspect for poor connections at the harness connector of the affected module. Refer to **Testing for Intermittent Conditions and**	-		

Step	Action	Values	Yes	No
Schematic Reference: Control Module References				
1	Did you perform the Diagnostic System Check - Vehicle?	-	Go to **Step 9**	Go to **Diagnostic System Check - Vehicle**
8	Replace the affected module Refer to **Control Module References** for replacement, setup and programming. Did you complete the replacement?	-	Go to **Step 9**	-
9	Operate the system in order to verify the repair. Did you find and correct the condition?	9-18 V	System OK	Go to **Step 2**

DTC B1405

DTC Descriptor

DTC B1405

Device Voltage Reference Output 2 Circuit

Diagnostic Fault Information

Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.

DTC B1405

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Battery Current Sensor Supply Voltage Circuit	B1405	B1405	-	-
Battery Current Sensor Signal Circuit	B1405	B1405	-	-
Battery Current Sensor Low Reference Circuit	-	B1405	-	-

Circuit/System Description

The battery current sensor is a 3-wire hall effect current sensor. The battery current sensor monitors the battery current. It directly inputs to the body control module (BCM). It creates a 5-volt pulse width modulation (PWM) signal of 128 Hz with a duty cycle of 0-100 percent. Normal duty cycle is between 5-95 percent. Between 0-5 percent and 95-100 percent are for diagnostic purposes.

Conditions for Running the DTC

- The ignition is ON.
- The engine is running.

Conditions for Setting the DTC

The BCM detects a duty cycle of PWM input signal is less than 4 percent or more than 96 percent for more 33 seconds.

Action Taken When the DTC Sets

The driver information center (DIC) displays the SERVICE BATTERY CHARGING SYSTEM warning message.

Conditions for Clearing the DTC

The DTC clears as current status when the battery sensed current returns to normal range for more than 5 seconds.

Reference Information

Schematic Reference

Starting and Charging Schematics

Connector End View Reference

Engine Electrical Connector End Views

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the battery current sensor.
2. Ignition OFF, test for less than 1.0 ohm of resistance between the low reference circuit terminal B and ground.
    - If greater than the specified range, test the low reference circuit terminal B for an open/high resistance the circuit tests normal replace the BCM.
3. Ignition ON, test for 5 volts between the battery current sensor supply voltage circuit terminal A and ground.

- If less than the specified range, test the battery current sensor supply voltage circuit terminal A for a short to ground or an open/high resistance. If the circuit test normal replace the BCM.

4. Test for 5 volts between the battery current sensor signal circuit terminal C and ground.
   - If less than 5 volts test the battery current sensor signal circuit terminal C for a short to ground or an open/high resistance. If the circuit test normal replace the BCM.
5. If all circuits test normal test or replace the battery current sensor.

Repair Procedures

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Control Module References** for BCM replacement, setup and programming
- **Battery Current Sensor Replacement**

DTC B1424

DTC Descriptor

DTC B1424

Device 1 Voltage Low

Diagnostic Fault Information

Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.

Circuit/System Description

Voltage at Pass Key 3 module is lower than the voltage being reported on the serial data line.

Conditions for Running the DTC

The ignition must be in Accessory or Run mode for this code to set.

Conditions for Setting the DTC

Module battery voltage between low voltage limits 6-9 volts for a minimum of 2 seconds and serial data voltage is greater than normal low voltage 9 volts.

Action Taken When the DTC Sets

Security telltale ON.

Conditions for Clearing the DTC

Module battery voltage is greater than normal voltage low limit 9 volts.

Reference Information

Schematic Reference

Theft Deterrent System Schematics

Connector End View Reference

Theft Deterrent System Connector End Views

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Circuit/System Testing

1. Ignition OFF, disconnect the theft deterrent module (TDM) harness connector.
2. Measure and record the voltage at the battery terminals. Ignition in ON position, measure the voltage between the Accessory Voltage circuit and the ground circuit of the TDM. Verify that the voltage readings do not differ more than 1 volt.
    - If greater than 1 volt, test the Accessory Voltage circuit and the ground circuit of the TDM for an open/high resistance. If the circuits test normal, replace the TDM.
3. Go to **Charging System Test**

Repair Procedures

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

DTC B1516

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B1516 08

Battery Current Sensor Signal Invalid

DTC B1516 66

Battery Current Sensor Wrong Mounting Position

Diagnostic Fault Information

DTC B1516

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Battery Current Sensor Supply Voltage	B1516 08	B1516 08	-	-
Battery Current Sensor Signal Circuit	B1516 08	B1516 08	-	-
Battery Current Sensor Low Reference Circuit	B1516 08	B1516 08	-	-

Circuit/System Description

The battery current sensor is a 3-wire hall effect current sensor. The battery current sensor monitors the battery current. It directly inputs to the body control module (BCM). It creates a 5-volt pulse width modulation (PWM) signal of 128 Hz with a duty cycle of 0-100 percent. Normal duty cycle is between 5-95 percent. Between 0-5 percent and 95-100 percent are for diagnostic purposes

Conditions for Running the DTC

- The ignition is ON.
- The engine is running.

Conditions for Setting the DTC

B1516 08

The BCM detects a duty cycle of PWM input signal is less than 4 percent or more than 96 percent for more 33 seconds.

B1516 66

The BCM detects the battery current sensor is improperly installed.

Action Taken When the DTC Sets

The charge indicator illuminates in the instrument panel cluster (IPC) and the SERVICE BATTERY CHARGING SYSTEM warning message will be displayed in the driver

information center (DIC) if equipped.

Conditions for Clearing the DTC

The DTC clears as current status when the battery sensed current returns to normal range for more than 5 seconds

Reference Information

Schematic Reference

Starting and Charging Schematics

Connector End View Reference

Engine Electrical Connector End Views

Description and Operation

Charging System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Circuit/System Testing

B1516 08

Battery Current Sensor Signal Invalid

1. Ignition OFF, disconnect the harness connector at the battery current sensor.
2. Ignition OFF, test for less than 1.0 ohm of resistance between the low reference circuit terminal B and ground.
    - If greater than the specified range, test the low reference circuit for an open/high resistance. If the circuit tests normal replace the BCM.
3. Ignition ON, test for 4.8 - 5.2 volts between the battery current sensor supply voltage circuit terminal A and ground.
    - If less than the specified range, test the battery current sensor supply voltage circuit for a short to ground or an open/high resistance. If the circuit test normal replace the BCM.
4. Test for 4.8 - 5.2 volts between the battery current sensor signal circuit terminal C and

ground.

- If less than the specified range test the battery current sensor signal circuit for a short to ground or an open/high resistance. If the circuit test normal replace the BCM.

5. If all circuits test normal test or replace the battery current sensor.

B1516 66

When diagnosing B1516 66 verify that the battery current sensor is installed securely and positioned in the correct current flow direction.

- If the battery current sensor is not, remove and reinstall the sensor properly.

Repair Procedures

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Control Module References** for BCM replacement, setup and programming
- **Battery Current Sensor Replacement**

DTC B1517

Circuit Description

The body control module (BCM) has designated circuits for monitoring vehicle system voltage. The BCM monitors the system voltage to ensure that the voltage stays within the proper range. Damage to components and incorrect data may occur when the voltage is out of range. The BCM monitors the system voltage over an extended length of time. If the BCM detects the system voltage is outside an expected range for the calibrated length of time or the BCM battery sense circuits differ by 2 volts, DTC B1517 will set. Other modules also monitor system voltage the system voltage message is sent to the other modules and will default to 12.9 volts.

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC B1517 Battery Voltage

This vehicle has DTCs which include DTC symptoms. For more information, refer to **DTC Symptom Description** .

DTC B1517

DTC Symptom	DTC Symptom Descriptor
03	Voltage Below Threshold

07	Voltage Above Threshold
5A	Battery Voltage Plausibility Failure

Conditions for Running the DTC

This DTC shall run only if the BCM has power, ground and the ignition is not in START mode. This DTC shall execute regardless of the battery voltage.

Conditions for Setting the DTC

- The battery voltage falls below 11 volts, engine speed greater than 1,100 RPM for 15 seconds.
- The battery voltage is greater 16 volts, engine speed greater than 1,100 RPM for 15 seconds.
- The battery voltage differs by 2 volts on the BCM battery sense circuits for 10 seconds.

Action Taken When the DTC Sets

B1517 03

The Battery Indicator turns ON, the driver information center (DIC) displays the SERVICE BATTERY CHARGING SYSTEM message.

B1517 07

The Battery Indicator turns ON, the DIC displays the SERVICE BATTERY CHARGING SYSTEM message.

B1517 5A

The Battery Indicator turns ON, the DIC displays the SERVICE VEHICLE SOON Message.

Conditions for Clearing the DTC

- The DTC will clear current status when the fault is no longer present.
- A history DTC will clear after 50 consecutive ignition cycles if the condition for the malfunction is no longer present.
- Use a scan tool.

Test Description

The numbers below refer to the step numbers on the diagnostic table.

3: This step tests for the proper voltage at battery positive voltage sense circuits of the BCM. If voltages are not within the proper operating range, the voltage sense circuits needs to be tested.

4: This step tests the ground sense circuit of the BCM.

5: This step tests for the proper voltage of the battery sense circuits to the BCM. If voltage is not within the proper operating range, the battery positive voltage and ground circuits of the BCM need to be tested.

DTC B1517

Step	Action	Value(s)	Yes	No
Schematic Reference: Starting and Charging Schematics or **Power Distribution Schematics** and **Body Control System Schematics** **Connector End View Reference: Master Electrical Component List**				
1	Did you perform the Diagnostic System Check - Vehicle?	-	Go to **Step 2**	Go to **Diagnostic System Check - Vehicle**
2	1. Install a scan tool. 2. Turn ON the ignition, with the engine OFF. 3. With a scan tool, observe the Battery Voltage parameters in the body control module (BCM) data list. Do any of the voltages differ more than the specified value?	2 V	Go to **Step 5**	Go to **Step 3**
3	1. Turn OFF the ignition. 2. Disconnect the BCM harness connectors. 3. Turn ON the ignition, with the engine OFF. 4. Measure the voltage between the battery positive voltage circuits of the BCM and the ground circuits of the BCM. Do the voltages differ more than the specified value?	2 V	Go to **Step 9**	Go to **Step 4**
4	Measure the voltage from the battery positive voltage circuits of the BCM and a good ground.	2 V		

	Do the voltages differ more than the specified value?		Go to **Step 8**	Go to **Step 7**
5	1. Turn ON the ignition. 2. Measure the voltage between the battery positive voltage circuits of the BCM and the ground circuits of the BCM. Does the voltage measure within the specified range ?	10.5-15.5 V	Go to **Step 9**	Go to **Step 6**
6	Measure the voltage between the battery positive voltage circuits of BCM and a good ground. Does the voltage measure within the specified range ?	10.5-15.5 V	Go to **Step 8**	Go to **Step 7**
7	Test the battery positive voltage circuits of BCM for a high resistance or an open. Refer to **Circuit Testing** and **Wiring Repairs** . Did you find and correct the condition?	-	Go to **Step 11**	Go to **Step 9**
8	Test the ground circuits of the BCM for a high resistance or an open. Refer to **Circuit Testing** and **Wiring Repairs** . Did you find and correct the condition?	-	Go to **Step 11**	Go to **Step 9**
9	Inspect for poor connections at the harness connector of the BCM. Refer to **Testing for Intermittent Conditions and Poor Connections** and **Connector Repairs** . Did you find and correct the condition?	-	Go to **Step 11**	Go to **Step 10**
10	Replace the module BCM. Refer to **Control Module References** for replacement, setup and programming. Did you complete the	-	Go to **Step**	

Step	Action	Value(s)	Yes	No
Schematic Reference: Starting and Charging Schematics or **Power Distribution Schematics** and **Body Control System Schematics** **Connector End View Reference: Master Electrical Component List**				
11 1	Did you perform the Diagnostic System Check - Vehicle?	-		Go to **Diagnostic System Check - Vehicle**
	Does the DTC reset?	-	Go to **Step 2**	System OK

replacement?

1. Use the scan tool in order to clear the DTCs.
2. Operate the vehicle within the conditions for running the DTC, as specified in the supporting text.

Go to **Step 2**

DTC B1527

DTC Descriptor

DTC B1527

High Parasitic Load Detected

Diagnostic Fault Information

Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.

Circuit/System Description

The body control module (BCM) monitors the state of charge (SOC) of the electrical system. If the BCM senses that the SOC at key-on is 30 percent lower than what it was when the engine was running, DTC B1527 will set.

Conditions for Running the DTC

The ignition must be in Accessory or Run mode for this code to set.

Conditions for Setting the DTC

The SOC at key-on is 30 percent lower than when the engine was running and battery drain is more than 2 amps.

Action Taken When the DTC Sets

There is no battery telltale illuminated or DIC message displayed.

Conditions for Clearing the DTC

- The DTC will clear if the fault does not return after 50 consecutive ignition cycles.
- The DTC will clear when run SOC is greater than or equal to 80 percent.

Reference Information

Schematic Reference

Starting and Charging Schematics

Connector End View Reference

Engine Electrical Connector End Views

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

- **Scan Tool Data List**
- **Scan Tool Data Definitions**

Circuit/System Verification

Ignition ON, with scan tool compare the Prev. State of Charge and Start Up State of Charge parameters. The readings should not differ my more than 30%.

- If the readings differ by more than 30%, go to **Battery Electrical Drain/Parasitic Load Test**.

Repair Procedures

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

DTC P0560

Circuit Description

The powertrain control module (PCM) monitors the system voltage to ensure that the voltage stays within the proper range. Damage to components and incorrect data input can occur when the voltage is out of range. The PCM monitors the system voltage over an extended length of time. If the PCM detects a system voltage outside an expected range for the calibrated length of time, DTC P0560 will set.

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC P0560 System Voltage

Conditions for Running the DTC

- System voltage is below 11 volts or above 16 volts.
- Engine speed is above 1,500 RPM.
- Vehicle speed is below 40 km/h (25 mph).

Conditions for Setting the DTC

The PCM detects a system voltage out of range for 2 seconds.

Action Taken When the DTC Sets

- The PCM will not illuminate the malfunction indicator lamp (MIL).
- The PCM will command the charge indicator to be illuminated on the instrument panel cluster (IPC).
- The PCM will store conditions which were present when the DTC set as Failure Records data only.

Conditions for Clearing the DTC

- The PCM will command the message OFF after one trip in which the diagnostic test has been run and passed.
- The history DTC will clear after 40 consecutive warm-up cycles have occurred without a malfunction.
- The DTC can be cleared by using the scan tool Clear DTC Information function.

DTC P0560

Step	Action	Values	Yes	No
Schematic Reference: Starting and Charging Schematics Engine Controls Schematics . Connector End View Reference: Powertrain Control Module Connector End Views .				
1	Did you perform the Diagnostic System Check - Vehicle?	-	Go to **Step 2**	Go to **Diagnostic System Check - Vehicle**
	1. Install a scan tool. 2. Start the engine.			

2	3. With a scan tool, observe the Ignition 1 Signal parameter in the powertrain control module (PCM) data list. Does the scan tool indicate that the Ignition 1 Signal parameter is within the specified range?	11-15.5 V	Go to **Step 7**	Go to **Step 3**
3	Measure the voltage at the battery and compare it with the Ignition 1 Signal parameter. Are the battery voltage and Ignition 1 Signal readings different by more than the value specified?	0.8 V	Go to **Step 4**	Go to **Charging System Test**
4	Test the battery positive voltage circuit of the PCM for a high resistance. Refer to **Circuit Testing** and **Wiring Repairs** . Did you find and correct the condition?	-	Go to **Step 8**	Go to **Step 5**
5	Test the ground circuit of the PCM for a high resistance. Refer to **Circuit Testing** and **Wiring Repairs** . Did you find and correct the condition?	-	Go to **Step 8**	Go to **Step 6**
6	Inspect for poor connections at the harness connector of the PCM. Refer to **Testing for Intermittent Conditions and Poor Connections** and **Connector Repairs** . Did you find and correct the condition?	-	Go to **Step 8**	Go to **Step 7**
7	Replace the PCM. Refer to **Control Module References** for replacement, setup and programming. Did you complete the replacement?	-	Go to **Step 8**	-
	1. Review and record the scan tool Failure Records data.			

8	2. Use the scan tool in order to clear the DTC. 3. Operate the vehicle within the Conditions for Running the DTC as specified in the supporting text. 4. Using the scan tool, observe the Specific DTC Information for DTC P0560 until the test runs. Does the scan tool indicate that DTC P0560 failed this ignition?	-	Go to **Step 2**	System OK

DTC P0562

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P0562

System Voltage Low

Diagnostic Fault Information

DTC P0562

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition 1 Signal	P0562	P0562	-	-

Circuit/System Description

The engine control module (ECM) monitors the system voltage to ensure that the voltage stays within the proper range. Damage to components and incorrect data may occur when the voltage is out of range.

Conditions for Running the DTC

- The vehicle speed is above 8 km/h (5 mph).
- The system voltage is between 9.5-18 volts.

Conditions for Setting the DTC

The ECM detects a system voltage below 10 volts for 5 seconds.

Action Taken When the DTC Sets

- The ECM will command the charge indicator and or warning message to be illuminated on the instrument panel cluster (IPC) and the driver information center (DIC), if equipped.
- The ECM will not illuminate the malfunction indicator lamp (MIL).
- The ECM will store conditions, which were present when the DTC set as Fail Records data only.

Conditions for Clearing the DTC

- The ECM will command the message OFF after one trip in which the diagnostic test has been run and passed.
- The history DTC will clear after 40 consecutive warm-up cycles have occurred without a malfunction.
- Using the scan tool Clear DTC Information function can clear the DTC.

Reference Information

Schematic Reference

Starting and Charging Schematics

Connector End View Reference

Engine Electrical Connector End Views

Description and Operation

Charging System Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

- **Scan Tool Data List**
- **Scan Tool Data Definitions**

Circuit/System Verification

With the scan tool installed, ignition ON and the engine OFF, observe the Ignition 1 Signal parameter in the ECM data list. The Ignition 1 Signal parameter should read 10.5 volts or greater.

Circuit/System Testing

1. Measure the voltage at the battery terminals and compare it with the Ignition 1 Signal parameter in the ECM data list. Verify that battery and Ignition 1 signal readings do not differ more than 1.0 volt.
    - If greater than 1.0 volt, test the Ignition 1 and ground circuits of the ECM for high resistance. If the circuits test normal replace the ECM.
2. Go to **Charging System Test**

Repair Procedures

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

Control Module References for ECM replacement, setup and programming

DTC P0563

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P0563

System Voltage High

Circuit/System Description

The engine control module (ECM) monitors the system voltage to ensure that the voltage stays within the proper range. Damage to components and incorrect data may occur when the

voltage is out of range.

Conditions for Running the DTC

- The vehicle speed is above 8 km/h (5 mph).
- The system voltage is between 9.5-18 volts.

Conditions for Setting the DTC

The ECM detects a system voltage above 16 volts for less than 1 second.

Action Taken When the DTC Sets

- The ECM will command the charge indicator and or warning message to be illuminated on the instrument panel cluster (IPC) and the driver information center (DIC), if equipped.
- The ECM will not illuminate the malfunction indicator lamp (MIL).
- The ECM will store conditions, which were present when the DTC set as Fail Records data only.

Conditions for Clearing the DTC

- The ECM will command the message OFF after one trip in which the diagnostic test has been run and passed.
- The history DTC will clear after 40 consecutive warm-up cycles have occurred without a malfunction.

Reference Information

Schematic Reference

Starting and Charging Schematics

Connector End View Reference

Engine Electrical Connector End Views

Description and Operation

Charging System Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections

- **Wiring Repairs**

Scan Tool Reference

- **Scan Tool Data List**
- **Scan Tool Data Definitions**

Diagnostic Aids

- A possible cause of this DTC could be overcharging with a battery charger or jump starting.
- A high voltage value in multiple modules indicates a concern in the charging system.

Circuit/System Verification

1. If the DTC is history, refer to **Charging System Test**
2. Start the engine, record the voltage at the battery terminals. Observe the Ignition 1 signal parameter in the ECM data list. Voltages should not differ by more than 1 volt.
    - If more than 1 volt, replace the ECM.

Repair Procedures

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

Control Module References for ECM replacement, setup and programming

DTC P0615 (3.8L)

Circuit Description

The powertrain control module (PCM) supplies a ground path for the CRANK relay when start enable has been requested. The PCM monitors this circuit for conditions that are incorrect for the commanded state. If the PCM detects an improper circuit condition, DTC P0615 will set.

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC P0615 Starter Relay Control Circuit

Conditions for Running the DTC

System voltage is between 9-16 volts.

Conditions for Setting the DTC

- The PCM detects an improper voltage level on the control circuit that controls the CRANK relay.
- The condition exists for at least 2 seconds.

Action Taken When the DTC Sets

- The PCM will not illuminate the malfunction indicator lamp (MIL).
- The PCM will store the conditions present when the DTC set as Fail Records data only.

Conditions for Clearing the MIL/DTC

The history DTC will clear after 40 consecutive warm-up cycles have occurred without a malfunction.

Diagnostic Aids

Ignition system DTCs set with the ignition switch in the START position if the CRANK relay or the starter is inoperative. When the PCM enables starter operation, the PCM also initiates the diagnostic test routines for DTCs P0335, P0340 and P0385. If a condition exists which prevents the engine from cranking, the PCM will not receive signal input from the CKP and CMP sensors and the DTCs will set.

Reviewing the Fail Records vehicle mileage since the diagnostic test last failed may assist in diagnosing the condition. The information may help determine how often the condition that set the DTC occurs.

Test Description

The numbers below refer to the step numbers on the diagnostic table.

2: Listen for an audible click when the CRANK relay operates. Turn the ignition switch back and forth from the ON to START positions. Repeat this as necessary.

3: Tests for voltage at the coil side of the CRANK relay.

4: Verifies that the PCM is providing ground to the CRANK relay.

5: Tests if ground is constantly being applied to the CRANK relay.

DTC P0615 (3.8L)

Step	Action	Yes	No
Schematic Reference: Starting and Charging Schematics Connector End View Reference: Engine Electrical Connector End Views			
1	Did you perform the Diagnostic System Check - Vehicle?		Go to **Diagnostic System Check**

		Go to **Step 2**	**- Vehicle**
2	1. Install a scan tool. 2. Turn ON the ignition, with the engine OFF. 3. Turn the ignition back and forth from the ON to START positions. Does the CRANK relay click with each command?	Go to **Step 3**	Go to **Starter Solenoid Does Not Click (3.8L)** or **Starter Solenoid Does Not Click (4.6L)**
3	1. Turn OFF the ignition. 2. Remove the CRANK relay. 3. Turn ON the ignition, with the engine OFF. 4. Probe the battery positive voltage of the CRANK relay coil circuit with a test lamp that is connected to a good ground. Does the test lamp illuminate?	Go to **Step 4**	Go to **Step 8**
4	1. Connect a test lamp between the control circuit of the CRANK relay and the battery positive voltage of the CRANK relay coil circuit. 2. Turn the ignition back and forth from the ON to START positions. Does the test lamp turn ON and OFF with each command?	Go to **Step 6**	Go to **Step 5**
5	Test the control circuit of the CRANK relay for a short to voltage or an open. Refer to **Circuit Testing** and **Wiring Repairs** . Did you find and correct the condition?	Go to **Step 11**	Go to **Step 7**
6	Inspect for poor connections at the CRANK relay. Refer to **Testing for Intermittent Conditions and Poor Connections** and **Connector Repairs** . Did you find and correct the condition?	Go to **Step 11**	Go to **Step 9**
	Inspect for poor connections at the powertrain control module (PCM). Refer		

7	to **Testing for Intermittent Conditions and Poor Connections** and **Connector Repairs** . Did you find and correct the condition?	Go to **Step 11**	Go to **Step 10**
8	Repair the battery positive voltage circuit of the CRANK relay. Refer to **Connector Repairs** . Did you complete the repair?	Go to **Step 11**	-
9	Replace the CRANK relay. Did you complete the replacement.	Go to **Step 11**	-
10	Replace the PCM. Refer to **Control Module References** for replacement, setup and programming. Is the action complete?	Go to **Step 11**	-
11	1. Review and record scan tool Fail Records data. 2. Clear DTCs. 3. Operate vehicle within Fail Records conditions as noted. 4. Using a scan tool, monitor the Specific DTC Information for DTC P0615. Does the scan tool indicate DTC P0615 failed this ignition?	Go to **Step 2**	System OK

DTC P0615 (4.6L)

Circuit Description

The engine control module (ECM) supplies 12 volts to the control circuit of the crank relay when start enable has been requested. The ECM monitors this circuit for conditions that are incorrect for the commanded state. If the ECM detects an improper circuit condition, crank relay DTC P0615 will set.

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC P0615 Starter Relay Control Circuit

Conditions for Running the DTC

System voltage is between 9-16 volts.

Conditions for Setting the DTC

- The ECM detects an improper voltage level on the control circuit that controls the crank relay.
- The condition exists for at least 2 seconds.

Action Taken When the DTC Sets

- The ECM will not illuminate the malfunction indicator lamp (MIL).
- The ECM will store the conditions present when the DTC set as Failure Records data only.

Conditions for Clearing the MIL/DTC

- The history DTC will clear after 40 consecutive warm-up cycles have occurred without a malfunction.
- The DTC can be cleared by using the scan tool Clear DTC Information function.

Diagnostic Aids

Ignition system DTCs set with the ignition switch in the START position if the crank relay or the starter is inoperative. When the ECM enables starter operation, the ECM also initiates the diagnostic test routines for other DTCs. If a condition exists which prevents the engine from cranking, the ECM will not receive signal input from the crankshaft position (CKP) and camshaft position (CMP) sensors and the DTCs will set.

Reviewing the Failure Records vehicle mileage since the diagnostic test last failed may assist in diagnosing the condition. The information may help determine how often the condition that set the DTC occurs.

Test Description

The numbers below refer to the step numbers on the diagnostic table.

2: Listen for an audible click when the crank relay operates. Turn the ignition switch back and forth from the ON to START positions. Repeat this as necessary.

3: This step tests the ground circuit of the crank relay.

4: This step verifies that the ECM is providing 12 volts to the control circuit of crank relay.

5: This step tests for an open in the control circuit to the crank relay.

DTC P0615 (4.6L)

Step	Action	Yes	No
Schematic Reference: Starting and Charging Schematics **Connector End View Reference: Power and Grounding Connector End Views**			
1	Did you perform the Diagnostic System Check - Vehicle?	Go to **Step 2**	Go to **Diagnostic System Check - Vehicle**
2	1. Install a scan tool. 2. Turn ON the ignition, with the engine OFF. 3. Turn the ignition back and forth from the ON to START positions. Does the crank relay click with each command?	Go to **Step 3**	Go to **Starter Solenoid Does Not Click (3.8L)** or **Starter Solenoid Does Not Click (4.6L)**
3	1. Turn OFF the ignition. 2. Remove the crank relay. 3. Turn ON the ignition, with the engine OFF. 4. Test the ground circuit of the crank relay with a test lamp that is connected to battery positive. Does the test lamp illuminate?	Go to **Step 4**	Go to **Step 8**
4	1. Connect a test lamp between the crank relay control circuit and the crank relay ground circuit of the crank relay. 2. Turn the ignition back and forth from the ON to START positions. Does the test lamp turn ON and OFF with each command?	Go to **Step 6**	Go to **Step 5**
5	Test the control circuit of the crank relay for an open or a high resistance. Refer to **Circuit Testing** and **Wiring Repairs** . Did you find and correct the condition?	Go to **Step 11**	Go to **Step 7**
	Inspect for poor connections at the crank relay. Refer to **Testing for**		

6	**Intermittent Conditions and Poor Connections** and **Connector Repairs** . Did you find and correct the condition?	Go to **Step 11**	Go to **Step 9**
7	Inspect for poor connections at the engine control module (ECM). Refer to **Testing for Intermittent Conditions and Poor Connections** and **Connector Repairs** . Did you find and correct the condition?	Go to **Step 11**	Go to **Step 10**
8	Repair the ground circuit of the crank relay. Refer to **Connector Repairs** . Did you complete the repair?	Go to **Step 11**	-
9	Replace the crank relay. Did you complete the replacement?	Go to **Step 11**	-
10	Replace the ECM. Refer to **Control Module References** for replacement, setup and programming. Did you complete the replacement?	Go to **Step 11**	-
11	1. Review and record the scan tool Failure Records data. 2. Clear the DTCs. 3. Operate the vehicle within the Failure Records conditions as noted. 4. Using a scan tool, monitor the Specific DTC Information for DTC P0615. Does the scan tool indicate DTC P0615 failed this ignition?	Go to **Step 2**	System OK

DTC P0621

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P0621

Generator L-Terminal Circuit

Circuit/System Description

The engine control module (ECM)/powertrain control module (PCM) uses the generator turn ON signal circuit to control the load of the generator on the engine. A high side driver in the ECM/PCM applies a voltage to the voltage regulator. This signals the voltage regulator to turn the field circuit ON and OFF. The ECM/PCM monitors the state of the generator turn ON signal circuit. The ECM/PCM should detect low voltage on the generator turn ON signal circuit when the ignition is ON and the engine is OFF or when the charging system malfunctions. With the engine running, the ECM/PCM should detect high voltage on the generator turn ON signal circuit. The ECM/PCM performs key ON and RUN tests to determine the status of the generator turn ON signal circuit.

Conditions for Running the DTC

Key ON Test

- No generator, crankshaft position (CKP) sensors or camshaft position (CMP) sensor DTCs are set.
- The ignition is in RUN position.
- The engine is not running.

RUN Test

- No generator, CKP sensors, CMP sensor DTCs are set.
- The engine is running.

Conditions for Setting the DTC

- During the key ON test, the ECM/PCM detects high voltage on the generator turn ON signal circuit for at least 5 seconds.
- During the RUN test the ECM/PCM detects low voltage on the generator turn ON signal circuit for at least 15 seconds.

Action Taken When the DTC Sets

- The ECM/PCM will command the charge indicator and or warning message to be illuminated on the instrument panel cluster (IPC) and the driver information center (DIC), if equipped.
- The ECM/PCM will not illuminate the malfunction indicator lamp (MIL).
- The ECM/PCM will store conditions, which were present when the DTC set as Fail Records data only.

Conditions for Clearing the DTC

The history DTC will clear after 40 consecutive warm-up cycles have occurred without a malfunction.

Reference Information

Schematic Reference

Starting and Charging Schematics

Connector End View Reference

Engine Electrical Connector End Views

Description and Operation

Charging System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

- **Scan Tool Data List**
- **Scan Tool Data Definitions**

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the generator.
2. Ignition ON, test for less than 1 volt between the generator turn ON signal and ground.
    - If greater than the specified range, test the generator turn ON signal circuit for a short to voltage. If the circuit tests normal, replace the ECM/PCM.
3. Engine running, test for greater than 3.5 volts between the generator turn ON signal and ground.
    - If less than the specified range, test the generator turn ON signal circuit for a short to ground, an open or a high resistance. If the circuit tests normal, replace the ECM/PCM.
4. If the circuit test normal during the Ignition ON/Run tests, replace the generator.

Repair Procedures

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Generator Replacement (RPO L26)** or **Generator Replacement (RPO LD8)** for generator replacement
- **Control Module References** for ECM/PCM replacement, setup and programming

DTC P0622 (GAS)

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P0622

Generator F-Terminal Circuit

Circuit/System Description

The engine control module (ECM)/powertrain control module (PCM) uses the generator field duty cycle signal circuit to monitor the duty cycle of the generator. The generator field duty cycle signal circuit connects to high side of the field windings in the generator. A pulse width modulated (PWM) high side driver in the voltage regulator turns the field windings ON and OFF. The ECM/PCM uses the PWM signal input to determine the generator load on the engine. This allows the ECM/PCM to adjust the idle speed to compensate for high electrical loads. The ECM/PCM monitors the status of the generator field duty cycle signal circuit. When the key is in the RUN position and the engine is OFF, the ECM/PCM should detect a duty cycle near 0 percent. However, when the engine is running, the duty cycle should be between 5-95 percent.

Conditions for Running the DTC

- The vehicle speed is above 8 km/h (5 mph).
- The system voltage is between 9.5-18 volts.

Conditions for Setting the DTC

The ECM/PCM detects an out of range PWM signal during the KEY ON test the ECM/PCM detects, a PWM signal greater than 65 percent for at least 5 seconds or during the RUN test a PWM signal less than 5 percent for at least 15 seconds.

Action Taken When the DTC Sets

- The ECM/PCM will command the charge indicator and or warning message to be illuminated on the instrument panel cluster (IPC) and the driver information center (DIC), if equipped.
- The ECM/PCM will not illuminate the malfunction indicator lamp (MIL).
- The ECM/PCM will store conditions, which were present when the DTC set as Fail Records data only.

Conditions for Clearing the DTC

- The ECM/PCM will command the message OFF after one trip in which the diagnostic test has been run and passed.
- The history DTC will clear after 40 consecutive warm-up cycles have occurred without a malfunction.

Reference Information

Schematic Reference

Starting and Charging Schematics

Connector End View Reference

Engine Electrical Connector End Views

Description and Operation

Charging System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

- **Scan Tool Data List**
- **Scan Tool Data Definitions**

Circuit/System Verification

With the scan tool installed, ignition ON and the engine running, observe the GEN-F Terminal Signal parameter in the ECM/PCM data list. The GEN-F Terminal Signal parameter should

read between 5-95 percent.

Circuit/System Testing

1. Ignition OFF, disconnect the generator harness connector.
2. The ignition ON, engine OFF, connect a test lamp to battery positive voltage and repeatedly probe the generator field duty cycle circuit, harness side while monitoring the GEN-F Terminal Signal Parameter in the data list. It should change from 0 percent to above 95 percent.
    - If the GEN-F Terminal Signal parameter was not affected by the test lamp, test the GEN-F Terminal Signal circuit for a short to ground, a high resistance, an open circuit. If the circuit tests normal replace the ECM/PCM.
3. If the circuit test normal during the Ignition ON/Run tests and the ECM/PCM parameter changed from 0 percent to above 95 percent replace the generator.

Repair Procedures

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Control Module References** for ECM/PCM replacement, setup and programming
- **Generator Replacement (RPO L26)** or **Generator Replacement (RPO LD8)** for generator replacement

DTC P1668

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P1668

Generator L-Terminal Control Circuit

Circuit/System Description

The engine control module (ECM) uses the generator turn on signal circuit to control the load of the generator on the engine. A high side driver in the ECM applies a voltage to the voltage regulator. This signals the voltage regulator to turn ON the field circuit ON and OFF. The ECM monitors the state of the generator turn ON signal circuit. The ECM should detect low

voltage on generator turn ON signal circuit voltage when the ignition is ON and the engine is OFF or when the charging system malfunctions. With the engine running, the ECM should detect high voltage on the generator turn ON signal circuit. The ECM performs key ON and RUN tests to determine the status of the generator turn ON signal circuit.

Conditions for Running the DTC

Key ON Test

- No generator, crankshaft position (CKP) sensors or camshaft position (CMP) sensor DTCs are set.
- The ignition is in RUN position.
- The engine is not running.

RUN Test

- No generator, CKP sensors, CMP sensor DTCs are set.
- The engine is running.

Conditions for Setting the DTC

During the Key ON test the ECM detects a high signal voltage on the generator turn ON signal circuit for at least 5 seconds or during the RUN test the ECM detects a low signal voltage on the generator turn ON signal circuit for at least 15 seconds.

Action Taken When the DTC Sets

- The ECM will command the charge indicator and or warning message to be illuminated on the instrument panel cluster (IPC) and the driver information center (DIC), if equipped.
- The ECM will not illuminate the malfunction indicator lamp (MIL).
- The ECM will store conditions, which were present when the DTC set as Fail Records data only.

Conditions for Clearing the DTC

- The ECM will command the message OFF after one trip in which the diagnostic test has been run and passed.
- The history DTC will clear after 40 consecutive warm-up cycles have occurred without a malfunction.

Reference Information

Schematic Reference

Starting and Charging Schematics

Connector End View Reference

Engine Electrical Connector End Views

Description and Operation

Charging System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

- **Scan Tool Data List**
- **Scan Tool Data Definitions**

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the generator.
2. Ignition ON, test for less than 1 volt between the generator turn on signal and ground.
    - If greater than the specified range, test the generator turn on signal circuit for a short to voltage. If the circuit tests normal, replace the ECM.
3. Engine Running, test for greater than 3.5 volts between the generator turn on signal and ground.
    - If less than the specified range, test the generator turn on signal circuit for a short to ground, an open or a high resistance. If the circuit tests normal, replace the ECM.
4. If all circuits test normal replace the generator.

Repair Procedures

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Control Module References** for ECM replacement, setup and programming
- **Generator Replacement (RPO L26)** or **Generator Replacement (RPO LD8)**

SYMPTOMS - ENGINE ELECTRICAL

IMPORTANT: The following steps must be completed before using the

symptom tables.

- Perform **Diagnostic System Check - Vehicle**
  - There are no DTCs set.
  - The control modules can communicate via the serial data link.
- Review the system descriptions and operations in order to familiarize yourself with the system functions. Refer to one of the following system operations:
  - **Battery Description and Operation**
  - **Starting System Description and Operation**
  - **Charging System Description and Operation**

Visual/Physical Inspection

- Inspect for aftermarket devices which could affect the operation of the Starting and Charging Systems. Refer to **Checking Aftermarket Accessories**
- Inspect the easily accessible or visible system components for obvious damage or conditions which could cause the symptom.

Intermittent

Faulty electrical connections or wiring may be the cause of intermittent conditions. Refer to **Testing for Intermittent Conditions and Poor Connections**

Symptom List

Refer to a symptom diagnostic procedure from the following list in order to diagnose the symptom:

- **Starter Solenoid Does Not Click (3.8L)** or **Starter Solenoid Does Not Click (4.6L)**
- **Starter Solenoid Clicks, Engine Does Not Crank**
- **Engine Cranks Slowly**
- **Battery Inspection/Test**
- **Battery Electrical Drain/Parasitic Load Test**
- **Battery Common Causes of Malfunction**
- **Starter Motor Noise Diagnosis**
- **Charging System Test**
- **Generator Noise Diagnosis**

BATTERY INSPECTION/TEST

Tools Required

J 42000 Battery Tester. See **Special Tools**.

Diagnostic Aids

IMPORTANT:

- **Failure to properly understand the battery and its function could lead to a misdiagnosis and unneeded repairs. Refer to Battery Description and Operation and Battery Common Causes of Malfunction for more information.**
- **If testing an AGM battery with the J 42000 , add 100 to the CCA rating of the battery and enter that amount into the tester when prompted for the CCA rating. See Special Tools. For instance, if the AGM batteries CCA rating is 500 amps, enter 600 into the J 42000 . See Special Tools. Perform this modification only if the J 42000 does not ask if you are testing an AGM battery. See Special Tools. If these instructions are not followed when testing an AGM battery, an invalid test result and invalid test code will be obtained on the J 42000 . See Special Tools.**
- **The battery test using the J 42000 requires correct connections to the battery terminals. See Special Tools. A failure to obtain the correct connections during the test may result in a failed test on a good battery.**
- **When the J 42000 inquires "has the battery been charged", answer yes only if the battery was charged on this visit to the dealership. See Special Tools.**

Follow these instructions in order to avoid an incorrect diagnosis because of connections:

- If testing the vehicle with the battery cables still connected, wiggle the **J 42000** clips on the terminal (top post battery) or terminal bolt (side terminal battery). See **Special Tools**. This may cut through any coating or through any oxidation that may be present on the terminal or bolt.

  Even a new terminal or bolt may contain a protective coating that can insulate or cause a resistance in the test circuit.

- If correct connections to the battery terminal bolts (side terminal battery) in the vehicle are in doubt, perform the following steps:
  1. Disconnect the negative battery cable.
  2. Disconnect the positive battery cable.
  3. Install the test adapters on the terminals.

4. Follow the instructions for an Out-of-Vehicle test.

- If the tester displays a REPLACE BATTERY or BAD CELL-REPLACE result for a battery tested in the vehicle with the battery cables connected, perform the following steps:
  1. Disconnect the negative battery cable.
  2. Disconnect the positive battery cable.
  3. Install the tester adapters on side terminal batteries.
  4. Follow the instructions for an Out-of-Vehicle test.
  5. Replace the battery only if the Out-of-Vehicle test shows a REPLACE BATTERY or BAD CELL-REPLACE result. This prevents battery replacements that are due only to faulty battery cable connections.
- Use the correct terminal adapters on side terminal batteries.

  Do not use any common bolts or a combination of bolts, nuts and or washers as adapters when testing the battery.

  Use the test adapters that are provided with the **J 42000** or P/N 12303040 terminal adapters. See **Special Tools**. If the adapters that are provided with the **J 42000** require replacement, use P/N 12303040. See **Special Tools**. Any other adapter may not contact the correct areas of the battery terminal, causing a resistance that may result in an invalid battery test result.

Battery Inspection/Test

Step	Action	Values	Yes	No
CAUTION: **Refer to BATTERY DISCONNECT CAUTION .** **IMPORTANT:** **Always write the test code displayed by the tester on the repair order for any warranty purposes. The number is a unique code that describes the test data for a particular battery at a particular time. The test code may occasionally repeat when you retest the same battery. More often, each test will result in a different code. If the battery is replaced due to failing the test, only an Out-of-Vehicle test code is valid for warranty purposes.**				
1	Inspect the battery for a cracked, broken or damaged case, which may be indicated by battery acid leakage. Is the battery OK?	-	Go to **Step 2**	Go to **Step 15**
	Compare the cold cranking amperage (CCA) and reserve capacity (RC) and/or amp hour (AH) rating of the battery to the			

2	original battery or original equipment (OE) specification. Refer to **Battery Usage**. Does the battery meet or exceed the specifications?	-	Go to **Step 3**	Go to **Step 15**
3	1. Turn OFF the ignition. 2. Attempt to rotate the negative battery cable connector clockwise with light finger pressure. Does the negative connector rotate?	-	Go to **Step 4**	Go to **Step 5**
4	Use a torque wrench in order to verify the torque to loosen the negative battery terminal. Is the torque above the specified value?	10 N.m (88 lb in)	Go to **Step 9**	Go to **Step 8**
5	Attempt to rotate the positive battery cable connector clockwise with light finger pressure. Does the positive connector rotate?	-	Go to **Step 7**	Go to **Step 6**
6	**IMPORTANT:** **Ensure that all of the electrical loads are turned OFF.** 1. Install the **J 42000** Battery Tester. See **Special Tools**. 2. Follow the directions supplied with the tester for an In-Vehicle test. 3. Follow any directions displayed on the tester. 4. If the tester calls for charging the battery, refer to **Battery Charging**. Did the tester pass the battery?	-	Go to **Step 14**	Go to **Step 8**
7	Use a torque wrench in order to verify the torque to loosen the positive battery terminal.	10 N.m (88 lb in)		

	Is the torque above the specified value?		Go to **Step 10**	Go to **Step 8**
8	1. Disconnect the negative battery cable. 2. Disconnect the positive battery cable. 3. Clean and wire brush the lead face of both battery terminals and the metal contact rings in both cable connectors. 4. Remove the bolts from the cable connectors in order to provide access to the connector rings as needed. 5. If either of the battery terminals or the cable rings are excessively damaged or corroded, replace as needed. Did you complete the repair?	-	Go to **Step 11**	-
9	1. Disconnect the negative battery cable. 2. Inspect for the following conditions and repair as needed: **Side Post Battery** • The cable bolt is too long or deformed at the end. • There is foreign material present inside the nut in the battery terminal. • Damage to the battery terminal face or cable connector ring **Top Post Battery**	-		-

	• There is foreign material present on the battery terminal face or cable connector ring. • Damage to the battery terminal face or cable connector ring Did you complete the repair?		Go to **Step 10**	
10	1. Disconnect the positive battery cable. 2. Inspect for the following conditions and repair as needed: **Side Post Battery** • The cable bolt is too long or deformed at the end. • There is foreign material present inside the nut in the battery terminal. • Damage to the battery terminal face or cable connector ring **Top Post Battery** • There is foreign material present on the battery terminal face or cable connector ring. • Damage to the battery terminal face or cable connector ring Did you complete the repair?	-	Go to **Step 11**	-
	IMPORTANT: **Ensure that both battery cables are disconnected and the directions for**			

an Out-of-Vehicle test are followed.

Step	Action	Values	Yes	No
CAUTION: Refer to **BATTERY DISCONNECT CAUTION** . **IMPORTANT:** Always write the test code displayed by the tester on the repair order for any warranty purposes. The number is a unique code that describes the test data for a particular battery at a particular tim The test code may occasionally repeat when you retest the same battery. More often, each test wi result in a different code. If the battery is replaced due to failing the test, only an Out-of-Vehicle te code is valid for warranty purposes.				
1	1. Install the **J 42000** . See **Special Tools**. 2. Follow the directions supplied with the tester for an Out-of-Vehicle test. 3. Follow any directions displayed on the tester. 4. If the tester calls for charging the battery, refer to **Battery Charging**. Did the tester pass the battery?		Go to **Step 2**	Go to **Step 15**
1	Inspect the battery for a cracked, broken or damaged case, which may be indicated by battery acid leakage. Is the battery OK?	-	Go to **Step 12**	Go to **Step 15**
2	1. Press the CODE button on the **J 42000** . See **Special Tools**. 2. For warranty purposes, write the displayed code on the repair order. Did you complete this action?	-	Go to **Step 3**	-
12	Compare the cold cranking amperage (CCA) and reserve capacity (RC) and/or amp hour (AH) rating of the battery to the original battery or original equipment (OE) specification. Refer to **Battery Usage**. Does the battery meet or exceed the specifications?	-	Go to **Step 13**	Go to **Step 15**
13	1. Connect the positive battery cable to the batteries positive terminal. **NOTE:** Refer to **FASTENER NOTICE** . 2. Tighten the positive battery cable to the specified value. 3. Connect the negative battery cable to the battery negative terminal. 4. Tighten the negative battery cable to the specified value. Are the cable bolts properly tightened?	17 N.m (13 lb ft)	Battery OK	-
	1. Press the CODE button on the **J 42000** . See **Special**			

13	**Tools:** 1. Turn OFF the ignition. 2. Attempt to rotate the negative battery cable connector clockwise with light finger pressure. Does the negative connector rotate?	- -			-
14	For warranty purposes, write the displayed code on the repair order. Did you complete the replacement?		Battery OK	Go to **Step 4**	Go to **Step**
15	Use a torque wrench in order to verify the torque to loosen the negative battery terminal. Is the torque above the specified	10 N.m (88 lb in)	Battery OK		-

Replace the battery. Refer to **Battery Replacement**.
Did you complete the replacement?

BATTERY CHARGING

Tools Required

J 42000 Battery Tester. See **Special Tools**.

- For best results, use an automatic taper-rate battery charger with a voltage capability of 16 volts.
- The charging area should be well ventilated.
- Do not charge a battery that appears to be frozen. Allow the battery to warm to room temperature and test it using the **J 42000** before charging. See **Special Tools**.

Battery State of Charge

IMPORTANT: Using voltage to determine the batteries state of charge (SOC) is only accurate after the battery has been at rest for 24 hours. This is enough time for the acid in each cell to equalize. If the battery has been charged or discharged in the past 24 hours, the battery SOC will only be an estimate.

The maintenance-free batteries SOC is estimated by reading the voltage of the battery across the battery terminals. Because the voltage is affected by current flow into or out of the battery, the engine must be stopped and all electrical loads turned OFF, including parasitic loads, when checking the voltage. The voltage can also be affected if the battery has just been charged or discharged, so it is important to consider what has happened to the battery in the time just before testing. Use the following procedure to determine the batteries SOC:

1. Be sure all electrical loads are turned OFF.
2. Determine whether the battery has been used in a vehicle or charged within the past 12 hours.
   - If the answer is no, the terminal voltage will be stabilized and no action is necessary

before reading the voltage. Skip to step 3.

- If the answer is yes, terminal voltage will not be stabilized and you should wait 12 hours since the last time the battery was used.

3. Estimate the battery temperature by determining the average temperature to which the battery has been exposed for the past 12 hours.

IMPORTANT: The table is accurate to 10 percent only after the battery has been at rest for 12 hours.

4. Measure the battery voltage at the battery terminals. Refer to the following table to determine the SOC according to the estimated battery temperature:

Battery Charging

Battery Voltage	% Charge at 0°C (32°F)	% Charge at 25°C (75°F)
12.75 V	100%	100%
12.7 V	100%	90%
12.6 V	90%	75%
12.45 V	75%	65%
12.2 V	65%	45%
12 V	40%	20%

Use the SOC information as follows:

- A battery with a SOC that is below 65 percent must always be recharged before returning it to service or continuing storage.
- A battery with a SOC that is 65 percent or greater is generally considered to be charged enough in order to be returned to normal service or in order to continue storage. However, if the battery is being used in slow traffic or with short drive times or if the temperature is very hot or very cold, the battery should be fully charged, to at least 90 percent, before returning it to service or continuing storage.

Charging Time Required

The time required to charge a battery will vary depending upon the following factors:

- The battery charger capacity-The higher the charger amperage, the less time it will take to charge the battery.
- The SOC of the battery-A completely discharged battery requires more than twice as much charging time as a half charged battery. In a discharged battery with a voltage below 11 volts, the battery has a very high internal resistance and may only accept a very low current at first. Later, as the charging current causes the acid content to increase in the electrolyte, the charging current will increase. Extremely discharged batteries may

not activate the reversed voltage protection in some chargers. Refer to the manufacturer's instructions for operating this circuitry.

- The temperature of the battery-The colder the battery is, the more time it takes to recharge the battery. The charging current accepted by a cold battery is very low at first. As the battery warms, the charging current will increase.

Charging Procedure

NOTE: Turn OFF the ignition when connecting or disconnecting the battery cables, the battery charger or the jumper cables. Failure to do so may damage the PCM or other electronic components.

NOTE: Refer to Fastener Notice .

When charging side-terminal batteries with the battery cables connected, connect the charger to the positive cable bolt and to a ground located away from the battery. When charging side-terminal batteries with the battery cables disconnected, install the battery side terminal adapters and connect the charger to the adapters.

Tighten: Tighten the battery side terminal adapters to 15 N.m (11 lb ft).

Use the following procedure to charge the battery:

1. Turn OFF the charger.
2. Ensure that all of the battery terminal connections are clean and tight.
3. Connect the charger positive lead to the battery positive terminal on the battery or the remote jumper stud underhood.

   NOTE: Do not connect the negative charger lead to the housings of other vehicle electrical accessories or equipment. The action of the battery charger may damage such equipment.

4. Connect the negative charger lead to a solid engine ground or to a ground stud in the engine compartment that is connected directly to the battery negative terminal, but away from the battery. If the negative battery cable is disconnected and a terminal adapter is being used, connect directly to the adapter.
5. Turn ON the charger and set to the highest setting for normal charging.
6. Inspect the battery every half hour after starting the battery charger.
   - Charge the battery until the taper-rate charger indicates that the battery is fully charged.
   - Estimate the battery temperature by feeling the side of the battery. If it feels hot to the touch or its temperature is over 45°C (125°F), discontinue charging and allow

the battery to cool before resuming charging.

7. After charging, test the battery. Refer to **Battery Inspection/Test**.

BATTERY ELECTRICAL DRAIN/PARASITIC LOAD TEST

Tools Required

J 38758 Parasitic Draw Test Switch. See **Special Tools**.

Diagnostic Aids

- Be sure to rule out any possible obvious influences, such as customer error or aftermarket equipment.
- Customer driving habits, such as regular short trips. This does not allow enough time to properly charge the battery. Refer to **Battery Description and Operation**.
- Verify that the battery and charging system are in proper working order. Refer to **Battery Charging** and **Charging System Test**.
- A battery discharging for no apparent reason while the vehicle is parked can be caused by an intermittent draw, such as a module waking up or a continuous draw, such as a dome light or stuck relay.
- Some systems and modules such as OnStar® and regulated voltage control (RVC), if equipped, are designed to wake-up, perform a task and go back asleep at regular intervals. Refer to **Body Control System Description and Operation** for the system or modules description and operation.
- Remote keyless entry (RKE) will wake up due to an outside input. Refer to **Keyless Entry System Description and Operation** .

IMPORTANT: The battery specification listed below is a generic specification. Refer to Battery Usage when testing the battery.

- The battery run down time will vary depending on cold cranking amperage (CCA) and reserve capacity (RC). If the CCA and RC are higher, then the battery run down time would be longer. If the CCA and RC are lower, then the battery run down time would be shorter. The graph below indicates roughly how many days a 690 CCA battery with at 110 min. RC (60.5 AH) starting at 80 percent state of charge will last with a constant current draw until it reaches 50 percent state of charge. Differences in battery rating and temperature will affect the results.

Battery Electrical Drain/Parasitic Load Test

Current Drain	Days
25 mA	30.5

50 mA	16.5
75 mA	11
100 mA	8.25
250 mA	3.3
500 mA	1.65
750 mA	1
1 A	0.8
2 A	0.4

CAUTION: Refer to Battery Disconnect Caution .

NOTE: Do not turn the parasitic draw test switch to the OFF position with the engine running. Damage will occur to the vehicle's electrical system.

NOTE: The test switch must be in the ON position when removing the fuses in order to maintain continuity in the electrical system. This avoids damaging the digital multimeter due to accidental overloading, such as a door being opened to change a fuse.

IMPORTANT: The switch knob on the J 38758 is marked ON and OFF. See Special Tools. When the switch knob is in the ON position, the circuit is closed and electrical current will pass through the switch. When the switch knob is in the OFF position, the circuit is open and electrical current will not pass through the switch.

1. Disconnect the battery negative cable from the battery negative terminal.
2. Install the male end of the **J 38758** to the battery ground terminal. See **Special Tools**.
3. Turn the **J 38758** knob to the OFF position. See **Special Tools**.
4. Install the battery negative cable to the female end of the **J 38758** . See **Special Tools**.
5. Turn the **J 38758** knob to the ON position. See **Special Tools**.
6. Road test the vehicle and activate ALL of the accessories, including the radio and air conditioning. This may take up to 30 minutes.
7. Park the vehicle. Turn the ignition switch to the OFF position and remove the ignition switch key.
8. Connect a 10A fused jumper wire to the test switch tool terminals.
9. Turn the **J 38758** knob to the OFF position. See **Special Tools**. The current now flows through the jumper wire.

10. Wait 1 minute. If the fuse blows, install an inductive ammeter to locate the current draw.
11. Turn the test switch ON and then remove the fused jumper wire.
12. Set a digital multimeter to the 10A scale.
13. Connect the digital multimeter to the test switch tool terminals.
14. Turn the **J 38758** knob to the OFF position. See **Special Tools**. The current flows now through the digital multimeter.
15. Wait 1 minute. Check and record the current reading.
    1. When there is a current reading on 2A or less, turn the **J 38758** knob to the ON position. See **Special Tools**. The electrical current will now pass through the switch.
    2. Then switch the digital multimeter down to the 2A scale for a more accurate reading when the **J 38758** knob is turned OFF. See **Special Tools**.
16. Turn the **J 38758** knob to the OFF position. See **Special Tools**. Wait 15 minutes for most vehicles.
17. Check and record the current reading.
18. Note the battery reserve capacity, amp hour rating. Refer to **Battery Usage**.
    1. Divide the reserve capacity by 4, amp hour rating by 2.4.
    2. Compare this to the multimeter milliampere reading taken in the previous step. The parasitic current drain should not exceed this number. Example: If a battery has a reserve capacity of 100 minutes, (60 A/H) the current drain should not exceed 25 mA.
19. If excessive current drain is not found at this time and there are no other apparent causes, complete the following:
    1. Using the MIN/MAX function of the digital multimeter, monitor the parasitic drain overnight or during the day. This will determine if something has been activated during that time frame.

       NOTE: The test switch must be in the ON position when removing the fuses in order to maintain continuity in the electrical system. This avoids damaging the digital multimeter due to accidental overloading, such as a door being opened to change a fuse.

       IMPORTANT: Removing fuses, relays and connectors to determine the failure area may wake up modules. You must wait for these modules to go to sleep or use the sleep function on the scan tool.

    2. When the vehicle has an unacceptable amount of parasitic current drain, remove

each fuse one at a time until the current drain falls to an acceptable level. This will indicate which circuit is causing the drain. Refer to **Power Distribution Schematics** to diagnose exactly which part of the suspect circuit is causing the parasitic drain. In some cases a non-fused circuit or component, such as a relay, is the cause of excessive parasitic current drain.

3. Repeat the parasitic current drain test procedure after any repair has been completed to make sure that the parasitic current drain is at an acceptable level.
4. When the cause of the excessive current drain has been located and repaired, remove the **J 38758** . See **Special Tools**.

20. Connect the battery negative cable to the battery negative terminal.

BATTERY COMMON CAUSES OF MALFUNCTION

A battery is not designed to last forever. With proper care, however, the battery will provide years of good service. If the battery tests good but still fails to perform well, the following are some of the more common causes:

- A vehicle accessory was left on overnight.
- The driving speeds have been slow with frequent stops, stop-and-go driving, with many electrical accessories in use, particularly air conditioning, headlights, wipers, heated rear window, cellular telephone, etc.
- The electrical load has exceeded the generator output, particularly with the addition of aftermarket equipment.
- Existing conditions in the charging system, including the following possibilities:
  - A slipping belt
  - A bad generator
- The battery has not been properly maintained, including a loose battery hold down or missing battery insulator if used.
- There are mechanical conditions in the electrical system, such as a short or a pinched wire, attributing to power failure. Refer to **General Electrical Diagnosis** .

Electrolyte Freezing

The freezing point of electrolyte depends on its specific gravity. A fully charged battery will not freeze until the ambient temperature gets below -54°C (-65°F). However, a battery with a low state of charge may freeze at temperatures as high as -7°C (+20°F). Since freezing may ruin a battery, the battery should be protected against freezing by keeping it properly charged. As long as the green eye is visible in the hydrometer, the freezing point of the battery will be somewhere below -32°C (-25°F).

Battery Protection During Vehicle Storage

Certain devices on the vehicle maintain a small continuous current drain, parasitic load, on the battery. A battery that is not used for an extended period of time will discharge. Eventually permanent damage will result. Discharged batteries will also freeze in cold weather. Refer to **Battery Inspection/Test**.

In order to maintain the battery state of charge while storing the vehicle for more than 30 days:

1. Ensure that the green dot is visible in the built-in hydrometer.

CAUTION: Refer to Battery Disconnect Caution .

2. Disconnect the battery ground cable to protect the battery from discharge by parasitic current drains.

When the battery cannot be disconnected:

1. Maintain a high state of charge.
2. Establish a regular schedule for recharging the battery every 20-45 days.

A battery that has remained in a discharged state for a long period of time is difficult to recharge or may be permanently damaged.

JUMP STARTING IN CASE OF EMERGENCY

CAUTION: Batteries produce explosive gases. Batteries contain corrosive acid. Batteries supply levels of electrical current high enough to cause burns. Therefore, in order to reduce the risk of personal injury while working near a battery, observe the following guidelines:

- **Always shield your eyes.**
- **Avoid leaning over the battery whenever possible.**
- **Do not expose the battery to open flames or sparks.**
- **Do not allow battery acid to contact the eyes or the skin.**
  - **Flush any contacted areas with water immediately and thoroughly.**
  - **Get medical help.**

NOTE: This vehicle has a 12 volt, negative ground electrical system. Make sure the vehicle or equipment being used to jump start the

engine is also 12 volt, negative ground. Use of any other type of system will damage the vehicle's electrical components.

1. Position the vehicle with the booster battery so that the jumper cables will reach.
   - Do not let the 2 vehicles touch.
   - Make sure that the jumper cables do not have loose ends or missing insulation.
2. Place an automatic transmission in PARK. If equipped with a manual transmission, place in NEUTRAL and block the wheels.
3. Turn OFF all electrical loads on both vehicles that are not needed.
4. Turn OFF the ignition on both vehicles.

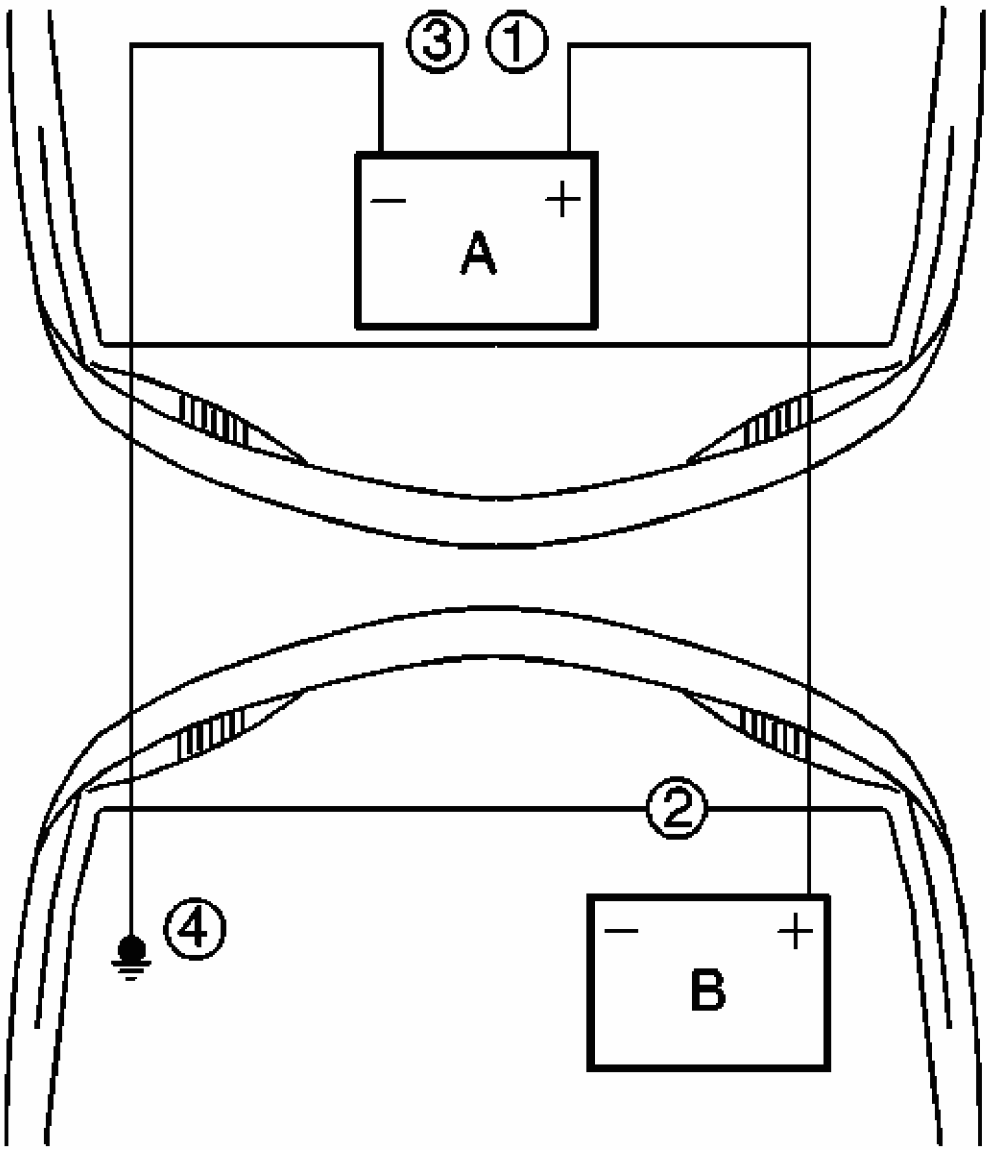


Fig. 10: Identifying Proper Jumper Cable Connection
Courtesy of GENERAL MOTORS CORP.

5. Connect the red positive (+) cable to the battery positive (+) terminal (2) of the vehicle with the discharged battery.

   Use a remote positive (+) terminal if the vehicle has one.

6. Connect the red positive (+) cable to the positive (+) terminal (1) of the booster battery.

Use a remote positive (+) terminal if the vehicle has one.

7. Connect the black negative (-) cable to the negative (-) terminal (3) of the booster battery.

CAUTION: Do not connect a jumper cable directly to the negative terminal of a discharged battery to prevent sparking and possible explosion of battery gases.

8. The final connection is made to a heavy, unpainted metal engine part (4) of the vehicle with the discharged battery.

   This final attachment must be at least 46 cm (18 in) away from the dead battery.

9. Start the engine of the vehicle that is providing the boost.

NOTE: Never operate the starter motor more than 15 seconds at a time without pausing in order to allow it to cool for at least 2 minutes. Overheating will damage the starter motor.

10. Crank the engine of the vehicle with the discharged battery.
11. The black negative (-) cable must be first disconnected from the vehicle that was boosted (4).
12. Disconnect the black negative (-) cable from the negative (-) terminal (3) of the booster battery.

NOTE: Do not let the cable end touch any metal. Damage to the battery and other components may result.

13. Disconnect the red positive (+) cable from the positive (+) terminal (1) of the booster battery.
14. Disconnect the red positive (+) cable from the remote positive (+) terminal (2) of the vehicle with the discharged battery.

CHARGING SYSTEM TEST

Charging System Test

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?	-	Go to **Step 2**	Go to **Diagnostic System Check - Vehicle**
	With the ignition OFF, install			

2	the Midtronics Digital Battery Analyzer and verify the condition of the battery. Is the battery sufficiently charged for testing?	-	Go to **Step 3**	Go to **Battery Inspection/Test**
3	1. Disconnect the Midtronics Digital Battery Analyzer. 2. Connect the Sun Vat 40 tester or equivalent to the battery. 3. Turn the ignition to the OFF/LOCK position. 4. Observe and record the battery voltage reading at the battery terminals on the Sun Vat 40 tester. 5. Start the engine and observe the system voltage reading on the tester. Does the voltage increase from the first specified (engine OFF) to the second (engine ON) specified range?	Engine Off = B+ Engine On = 13.9-15.5 V	Go to **Step 4**	Go to **Step 6**
4	1. Turn ON the following accessories: • Headlights - HI beams • A/C on Max • Blower Fan - On high • Rear window defogger • Heated seats, if equipped 2. Maintain engine speed at 2,500 RPM. Is voltage still within the specified value?	13.9-15.5 V	Go to **Step 5**	Go to **Step 6**
	1. Turn OFF all accessories.			

5	2. Turn OFF the ignition. 3. Connect a carbon pile tester to the vehicle. **IMPORTANT:** **When measuring generator output current, be sure the inductive probe encircles the generator output wire.** 4. Connect an inductive ammeter probe to the output circuit of the generator. 5. Start the engine. 6. Increase engine speed to 2,500 RPM. 7. Adjust the carbon pile as necessary in order to obtain the maximum current output. Is the generator output greater than or equal to the load test value as specified in **Generator Usage**	-	System OK	Go to **Step 10**
6	1. Turn the engine OFF. 2. Disconnect the generator harness connector. 3. Turn the ignition to the ON position. 4. Using a DMM, measure the voltage on the L-terminal circuit. Is the voltage greater than the specified value?	0 V	Go to **Step 11**	Go to **Step 7**
7	1. Turn the engine OFF. 2. Start the engine and check the voltage on the L-terminal.	5 V		

	Is the voltage within the specified value?		Go to **Step 8**	Go to **Step 12**
8	1. Turn the engine OFF. 2. Turn the ignition switch to ON position. 3. Using the scan tool, observe the duty cycle in the F-terminal signal parameter. Does the scan tool display the indicated value?	0 Percent	Go to **Step 9**	Go to **Step 13**
9	Connect a test lamp to B+ and repeatedly touch the F-terminal at the generator harness connector while monitoring the GEN-F terminal signal parameter on the scan tool. Does the scan tool indicate that the generator PWM is above the specified range?	90 Percent	Go to **Step 10**	Go to **Step 14**
10	1. Turn the engine OFF. 2. Inspect the generator B+ output terminal at the generator for an open or high resistance. Refer to **Circuit Testing** and **Wiring Repairs** . Did you find and correct the condition?	-	Go to **Step 19**	Go to **Step 15**
11	Test the L-terminal circuit for a short to voltage. Refer to **Circuit Testing** and **Wiring Repairs** . Did you find and correct the condition?	-	Go to **Step 19**	Go to **Step 16**
12	Test the L-terminal circuit for open or short to ground. Refer to **Circuit Testing** and **Wiring Repairs** .	-		

	Did you find and correct the condition?		Go to **Step 19**	Go to **Step 16**
13	Test the GEN-F terminal for a short to voltage. Refer to **Circuit Testing** and **Wiring Repairs** . Did you find and correct the condition?	-	Go to **Step 19**	Go to **Step 16**
14	Test the GEN-F terminal circuit for an open or short to ground. Refer to **Circuit Testing** and **Wiring Repairs** . Did you find and correct the condition?	-	Go to **Step 19**	Go to **Step 16**
15	Inspect for poor connections at the generator. Refer to **Circuit Testing** and **Wiring Repairs** . Did you find and correct the condition?	-	Go to **Step 19**	Go to **Step 18**
16	Inspect for poor connections at the harness connector of the engine control module (ECM). Refer to **Testing for Intermittent Conditions and Poor Connections** and **Connector Repairs** . Did you find and correct the condition?	-	Go to **Step 19**	Go to **Step 17**
17	**IMPORTANT:** **The replacement ECM must be programmed.** Replace the ECM. Refer to **Control Module References** for replacement, setup and programming.Did you complete the replacement?	-	Go to **Step 19**	-
18	Replace the generator. Refer to **Generator Replacement (RPO L26)** or **Generator Replacement (RPO LD8)**. Did you complete the	-	Go to **Step**	-

Step	replacement? **Action**	Value(s)	19 Yes	No
19	Operate the vehicle in order to verify the repair. Did you perform the Diagnostic System Check - Vehicle? Did you correct the condition?	- -	Go to **Step 2** System OK	Go to **Diagnost System Check - Vehicle Step 2**

CHARGE INDICATOR ALWAYS ON

Charge Indicator Always On

Step	Action	Value(s)	Yes	No
Schematic Reference: Starting and Charging Schematics **Connector End View Reference: Engine Electrical Connector End Views**				
1	Did you perform the Diagnostic System Check - Vehicle ?	-	Go to **Step 2**	Go to **Diagnostic System Check - Vehicle**
2	1. Start the engine. 2. Turn OFF all accessories. Does the battery charge indicator remain illuminated?	-	Go to **Step 3**	Go to **Testing for Intermittent Conditions and Poor Connections**
3	1. Install a scan tool. 2. Start the engine. 3. Turn OFF all accessories. 4. Increase engine speed to 1,500 RPM. 5. With a scan tool, observe the Battery Voltage parameter in the body control module (BCM) data list, engine control module (ECM)/powertrain control module (PCM) data list and the instrument panel cluster (IPC) data list. 6. Compare the voltages. Are all of the voltages within the specified range?	0.9-1.1 V	Go to **Step 4**	Go to **Step 5**
4	Are the voltages displayed within the specified range?	11-16 V	Go to **Step**	Go to **Charging**

			5	System Test
5	Test the battery positive voltage and ground circuits of the affected module for a high resistance or open. Refer to **Circuit Testing** and **Wiring Repairs** . Did you find and correct the condition?	-	Go to **Step 8**	Go to **Step 6**
6	Inspect for poor connections at the harness connector of the affected module. Refer to **Connector Repairs** . Did you find and correct the condition?	-	Go to **Step 8**	Go to **Step 7**
7	Replace the affected module. Refer to **Control Module References** for replacement, setup and programming. Did you complete the replacement?	-	Go to **Step 8**	-
8	Operate the system in order to verify the repair. Did you correct the condition?	-	System OK	Go to **Step 2**

CHARGE INDICATOR INOPERATIVE

Charge Indicator Inoperative

Step	Action	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?	Go to **Step 2**	Go to **Diagnostic System Check - Vehicle**
2	1. Turn OFF the ignition. 2. Turn ON the ignition, with the engine OFF. 3. Observe the battery charge indicator on the instrument cluster (IPC) during the bulb check. Does the battery charge indicator illuminate during the bulb check?	Go to **Testing for Intermittent Conditions and Poor Connections**	Go to **Step 3**

3	Replace the IPC. Refer to **Control Module References** for replacement, setup and programming. Did you complete the repair?	Go to **Step 4**	-
4	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to **Step 2**

GENERATOR NOISE DIAGNOSIS

Diagnostic Aids

Noise from a generator may be due to electrical or mechanical noise. Electrical noise or magnetic whine usually varies with the electrical load placed on the generator and is a normal operating characteristic of all generators. When diagnosing a noisy generator, it is important to remember that loose or misaligned components around the generator may transmit the noise into the passenger compartment and that replacing the generator may not solve the problem.

Generator Noise Diagnosis

Step	Action	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?	Go to **Step 2**	Go to **Diagnostic System Check - Vehicle**
2	Test the generator for proper operation using the Generator Tester. Refer to **Charging System Test**. Is the generator operating properly?	Go to **Step 3**	Go to **Step 12**
3	1. Start the engine. Verify that the noise can be heard. 2. Turn OFF the engine. 3. Disconnect the harness connector from the generator. 4. Start the engine. 5. Listen for the noise. Has the noise stopped?	Go to **Step 12**	Go to **Step 4**
	1. Turn OFF the engine. 2. Remove the drive belt. Refer to **Drive Belt Replacement** for the 3.8L engine or **Drive Belt**		

4	**Replacement** for the 4.6L engine. 3. Spin the generator pulley by hand. Does the generator shaft spin smoothly and without any roughness or grinding noise?	Go to **Step 5**	Go to **Step 12**
5	Inspect the generator for a loose pulley and/or pulley nut. Is the generator pulley or pulley nut loose?	Go to **Step 12**	Go to **Step 6**
6	1. Loosen all of the generator mounting bolts. 2. Tighten the generator mounting bolts to specifications and in the proper sequence, if necessary. Refer to **Generator Replacement (RPO L26)** or **Generator Replacement (RPO LD8)**. 3. Install the drive belt. Refer to **Drive Belt Replacement** for the 3.8L engine or **Drive Belt Replacement** for the 4.6L engine. 4. Start the engine. Has the noise decreased or stopped?	System OK	Go to **Step 7**
7	Inspect the generator for the following conditions: • Strained or stretched electrical connections • Hoses or other vehicle equipment resting on the generator, which may cause the noise to be transmitted into the passenger compartment Are any electrical connections pulling on the generator or are any hoses, etc. resting on the generator?	Go to **Step 8**	Go to **Step 9**
	1. Reroute the electrical connections		

8	to relieve the tension. 2. Reroute the hoses, etc. away from the generator. 3. Start the engine. Has the noise decreased or stopped?	System OK	Go to **Step 9**
9	Inspect the drive belt for proper tension. Refer to **Drive Belt Tensioner Diagnosis** for the 3.8L engine or **Drive Belt Tensioner Diagnosis** for the 4.6L engine. Is the drive belt loose?	Go to **Step 10**	Go to **Step 11**
10	1. Replace the drive belt tensioner. Refer to **Drive Belt Tensioner Replacement** for the 3.8L engine or **Drive Belt Tensioner Replacement** for the 4.6L engine. 2. Start the engine. Has the noise decreased or stopped?	System OK	Go to **Step 12**
11	Compare the vehicle with a known good vehicle. Do both vehicles make the same noise?	System OK	Go to **Step 12**
12	**IMPORTANT:** **If no definite generator problems were found, be sure that all other possible sources of objectionable noise are eliminated before replacing the generator. Replacing the generator may not change the noise level if the noise is a normal characteristic of the generator or the generator mounting.** Replace the generator. Refer to **Generator Replacement (RPO L26)** or **Generator Replacement (RPO LD8)**.Did you complete the replacement?	Go to **Step 13**	-
13	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to **Step 2**

STARTER SOLENOID DOES NOT CLICK (3.8L)

Starter Solenoid Does Not Click (3.8L)

Step	Action	Yes	No
Schematic Reference: Starting and Charging Schematics **Connector End View Reference: Master Electrical Component List**			
1	Did you perform the Diagnostic System Check - Vehicle?	Go to **Step 2**	Go to **Diagnostic System Check - Vehicle**
2	Turn the ignition switch to the START position. Does the engine crank?	Go to **Testing for Intermittent Conditions and Poor Connections**	Go to **Step 3**
3	Is the security indicator flashing?	Go to **Diagnostic System Check - Vehicle**	Go to **Step 4**
4	1. Install a scan tool. 2. Turn ON the ignition, with the engine OFF. 3. With a scan tool, observe the Current Power Mode parameter in the body control module (BCM) data list. 4. Turn the ignition switch to the START position. Does the scan tool display Crank?	Go to **Step 5**	Go to **Step 13**
5	1. Turn ON the ignition, with the engine OFF. 2. With a scan tool, observe the Starter Relay Command parameter in the powertrain control module (PCM) data list. 3. Turn the ignition switch to the START position. Does the scan tool display Yes?	Go to **Step 7**	Go to **Step 6**
	1. Turn ON the ignition, with the engine OFF.		

6	2. Verify that the transmission is in Park or Neutral. 3. With a scan tool, observe the IMS parameter in the Transmission data list. Does the scan tool display Park or Neutral?	Go to **Step 7**	Go to **Range Selector Displays Incorrect Range**
7	Turn the ignition switch to the START position. Do you hear the CRANK relay click?	Go to **Step 10**	Go to **Step 8**
8	1. Turn OFF the ignition. 2. Disconnect the CRANK relay. 3. Turn ON the ignition, with the engine OFF. 4. Connect a test lamp between the battery positive voltage circuit of the CRANK relay coil and a good ground. Does the test lamp illuminate?	Go to **Step 9**	Go to **Step 22**
9	1. Connect a test lamp between the battery positive voltage circuit of the CRANK relay coil and the control circuit of the CRANK relay. 2. Turn the ignition to the START position. Does the test lamp illuminate?	Go to **Step 17**	Go to **Step 15**
10	1. Turn OFF the ignition. 2. Disconnect the CRANK relay. 3. Connect a test lamp between the battery positive voltage circuit of the CRANK relay switch and a good ground. Does the test lamp illuminate?	Go to **Step 11**	Go to **Step 23**
	IMPORTANT: **Ensure the parking brake is applied and the transmission is in park equipped with an automatic transmission or neutral on a manual transmission.**		

11	Connect a 30-amp fused jumper between the battery positive voltage circuit of the CRANK relay switch and the starter solenoid crank voltage circuit.Does the engine crank?	Go to **Step 17**	Go to **Step 12**
12	Does the fuse in the jumper open?	Go to **Step 24**	Go to **Step 14**
13	1. Turn OFF the ignition. 2. Disconnect the BCM harness connector. 3. Connect a test lamp between the crank voltage circuit of the BCM and a good ground. 4. Turn the ignition to the START position. Does the test lamp illuminate?	Go to **Step 20**	Go to **Step 16**
14	Test the starter solenoid crank voltage circuit for a high resistance or open. Refer to **Circuit Testing** and **Wiring Repairs** . Did you find and correct the condition?	Go to **Step 30**	Go to **Step 18**
15	Test the control circuit of the CRANK relay for an open or short to battery voltage. Refer to **Circuit Testing** and **Wiring Repairs** . Did you find and correct the condition?	Go to **Step 30**	Go to **Step 21**
16	Test the crank voltage circuit of the BCM for a high resistance or open. Refer to **Circuit Testing** and **Wiring Repairs** . Did you find and correct the condition.	Go to **Step 30**	Go to **Step 19**
17	Inspect for poor connections at the CRANK relay. Refer to **Testing for Intermittent Conditions and Poor Connections** and **Connector Repairs** . Did you find and correct the condition?	Go to **Step 30**	Go to **Step 25**
18	Inspect for poor connections at the starter solenoid. Refer to **Testing for Intermittent Conditions and Poor Connections** and **Connector Repairs** . Did you find and correct the condition?	Go to **Step 30**	Go to **Step 26**
	Inspect for poor connections at the ignition switch. Refer to **Testing for Intermittent**		

19	**Conditions and Poor Connections** and **Connector Repairs** . Did you find and correct the condition?	Go to **Step 30**	Go to **Step 27**
20	Inspect for poor connections at the harness connector of the BCM. Refer to **Testing for Intermittent Conditions and Poor Connections** and **Connector Repairs** . Did you find and correct the condition?	Go to **Step 30**	Go to **Step 28**
21	Inspect for poor connections at the harness connector of the PCM. Refer to **Testing for Intermittent Conditions and Poor Connections** and **Connector Repairs** . Did you find and correct the condition?	Go to **Step 30**	Go to **Step 29**
22	Repair an open or high resistance in the battery positive voltage circuit of the CRANK relay coil. Refer to **Wiring Repairs** . Did you complete the repair?	Go to **Step 30**	-
23	Repair the open or high resistance in the battery positive voltage circuit of the CRANK relay switch. Refer to **Wiring Repairs** . Did you complete the repair?	Go to **Step 30**	-
24	Repair the short to ground in the starter solenoid crank voltage circuit. Refer to **Wiring Repairs** . Did you complete the repair?	Go to **Step 30**	-
25	Replace the CRANK relay. Did you complete the replacement?	Go to **Step 30**	-
26	Replace the starter motor. Refer to **Starter Motor Replacement (RPO L26)** or **Starter Motor Replacement (RPO LD8)**. Did you complete the replacement?	Go to **Step 30**	-
27	Replace the ignition switch. Refer to **Ignition and Start Switch Replacement** . Did you complete the replacement?	Go to **Step 30**	-
28	Replace the BCM. Refer to **Control Module References** for replacement, setup and programming. Did you complete the replacement?	Go to **Step 30**	-
	Replace the PCM. Refer to **Control**		

Step	Action	Yes	No
Schematic Reference: Starting and Charging Schematics **Connector End View Reference: Master Electrical Component List**			
29	Did you complete the replacement?	Go to **Step 30**	-
30 1	Did you perform the Diagnostic System Check - Vehicle? Did you correct the condition?	System OK	Go to **Diagnostic System Check**

STARTER SOLENOID DOES NOT CLICK (4.6L)

Starter Solenoid Does Not Click (4.6L)

Step	Action	Yes	No
Schematic Reference: Starting and Charging Schematics **Connector End View Reference: Master Electrical Component List**			
1	Did you perform the Diagnostic System Check - Vehicle?	Go to **Step 2**	Go to **Diagnostic System Check - Vehicle**
2	Turn the ignition switch to the start position. Does the engine crank?	Go to **Testing for Intermittent Conditions and Poor Connections**	Go to **Step 3**
3	1. Install a scan tool. 2. Turn ON the ignition, with the engine OFF. 3. With a scan tool, observe the Starter Relay Command parameter in the engine electrical data list. 4. Turn the ignition switch to the start position. Does the scan tool display ON?	Go to **Step 5**	Go to **Step 4**
4	1. Turn ON the ignition, with the engine OFF. 2. Verify that the transmission is in Park or Neutral. 3. With a scan tool, observe the PNP switch parameter in the engine electrical data list.		Go to **Range Selector Displays**

	Does the scan tool display Park/Neutral?	Go to **Step 6**	**Incorrect Range**
5	Turn the ignition switch to the start position. Did the crank relay click?	Go to **Step 8**	Go to **Step 6**
6	1. Turn OFF the ignition. 2. Remove the crank relay. 3. Turn ON the ignition, with the engine OFF. 4. Connect a test lamp between the control circuit of the crank relay coil and a good ground. 5. Turn the ignition switch to the start position. Does the test lamp illuminate?	Go to **Step 7**	Go to **Step 15**
7	1. Connect a test lamp between the control circuit of the crank relay coil and the ground circuit of the crank relay. 2. Turn the ignition switch to the start position. Does the test lamp illuminate?	Go to **Step 8**	Go to **Step 12**
8	1. Turn ON the ignition. 2. Connect a test lamp between the battery positive voltage circuit of the crank relay switch circuit and a good ground. 3. Turn the ignition switch to the start position. Does the test lamp illuminate?	Go to **Step 9**	Go to **Step 17**
9	**IMPORTANT:** **Ensure the parking brake is applied and the transmission is in park equipped with an automatic transmission or neutral on a manual transmission.** Connect a 30-amp fused jumper between the battery positive voltage circuit of the		

	crank relay switch circuit and the supply voltage circuit of the starter solenoid.Does the engine crank?	Go to **Step 13**	Go to **Step 10**
10	Does the fuse in the jumper open?	Go to **Step 18**	Go to **Step 11**
11	Test the supply voltage circuit of the starter solenoid for a high resistance or open. Refer to **Circuit Testing** and **Wiring Repairs** . Did you find and correct the condition?	Go to **Step 22**	Go to **Step 14**
12	Test the ground circuit of the crank relay for an open or a high resistance. Refer to **Circuit Testing** and **Wiring Repairs** . Did you complete the repair?	Go to **Step 22**	-
13	Inspect for poor connections at the crank relay. Refer to **Testing for Intermittent Conditions and Poor Connections** and **Connector Repairs** . Did you find and correct the condition?	Go to **Step 22**	Go to **Step 19**
14	Inspect for poor connections at the starter solenoid. Refer to **Testing for Intermittent Conditions and Poor Connections** and **Connector Repairs** . Did you find and correct the condition?	Go to **Step 22**	Go to **Step 20**
15	Repair an open or high resistance in the control circuit of the crank relay coil. Refer to **Wiring Repairs** . Did you complete the repair?	Go to **Step 22**	Go to **Step 16**
16	Inspect for poor connections at the harness connector of the ECM. Refer to **Testing for Intermittent Conditions and Poor Connections** and **Connector Repairs** . Did you find and correct the condition?	Go to **Step 22**	Go to **Step 21**
17	Repair the open or high resistance in the battery positive voltage circuit of the crank relay switch. Refer to **Wiring Repairs** . Did you complete the repair?	Go to **Step 22**	-
18	Repair the short to ground in the supply voltage circuit of the starter solenoid. Refer to **Wiring Repairs** .		

	Did you complete the repair?	Go to **Step 22**	-
19	Replace the crank relay. Did you complete the replacement?	Go to **Step 22**	-
20	Replace the starter motor. Refer to **Starter Motor Replacement (RPO L26)** or **Starter Motor Replacement (RPO LD8)**. Did you complete the replacement?	Go to **Step 22**	-
21	Replace the ECM. Refer to **Control Module References** for replacement, setup and programming. Did you complete the replacement?	Go to **Step 22**	-
22	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to **Step 2**

STARTER SOLENOID CLICKS, ENGINE DOES NOT CRANK

Starter Solenoid Clicks, Engine Does Not Crank

Step	Action	Yes	No
Schematic Reference: Starting and Charging Schematics			
1	Did you perform the Diagnostic System Check - Vehicle?	Go to **Step 2**	**Diagnostic System Check - Vehicle**
2	Turn the ignition to the START position. Did the starter solenoid click?	Go to **Step 3**	Go to **Starter Solenoid Does Not Click (3.8L)** or **Starter Solenoid Does Not Click (4.6L)**
3	Inspect the engine and belt drive system for mechanical binding, seized engine or seized generator. Does the engine move freely?		Go to **Engine Will Not Crank - Crankshaft Will Not Rotate** for the 3.8L engine or **Engine Will Not Crank -**

		Go to **Step 4**	**Crankshaft Will Not Rotate** for the 4.6L engine
4	Test the battery positive cable between the battery and the starter solenoid for high resistance. Refer to **Circuit Testing** and **Wiring Repairs** . Did you find and correct the condition?	Go to **Step 8**	Go to **Step 5**
5	Test the ground circuit between the battery and the starter motor for a high resistance. Refer to **Circuit Testing** and **Wiring Repairs** . Did you find and correct the condition?	Go to **Step 8**	Go to **Step 6**
6	Inspect for poor connections at the starter. Refer to **Testing for Intermittent Conditions and Poor Connections** and **Connector Repairs** . Did you find and correct the condition?	Go to **Step 8**	Go to **Step 7**
7	Replace the starter. Refer to **Starter Motor Replacement (RPO L26)** or **Starter Motor Replacement (RPO LD8)**. Did you complete the replacement?	Go to **Step 8**	-
8	Operate the system for which the symptom occurred. Did you correct the condition?	System OK	Go to **Step 2**

ENGINE CRANKS SLOWLY

Inspect the following items:

- Battery-Perform the Battery Inspection/Test. Refer to **Battery Inspection/Test**.
- Wiring-Inspect the wiring for damage. Inspect all connections to the starter motor, the solenoid, the battery and all ground connections. Refer to **Circuit Testing** , **Wiring Repairs** , **Testing for Intermittent Conditions and Poor Connections** and **Connector Repairs** .
- Engine-Verify that the engine is not seized.

If the battery, the wiring and the engine are functioning properly and the engine continues to crank slowly, replace the starter motor. Refer to **Starter Motor Replacement (RPO L26)** or **Starter Motor Replacement (RPO LD8)**.

STARTER MOTOR NOISE DIAGNOSIS

Diagnostic Aids

- Inspect the flywheel ring gear for damage or unusual wear.
- Shim the starter as required.
- In order to add pinion to ring gear clearance a full size shim must be used. Do not shim only one starter mounting bolt. There are three shims available in different shapes, for clearance, all are 1 mm (0.039 in) thick.

Starter Motor Noise Diagnosis

Step	Action	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?	Go to **Step 2**	Go to **Diagnostic System Check - Vehicle**
2	Start the engine. Does the starter operate normally?	Go to **Testing for Intermittent Conditions and Poor Connections**	Go to **Step 3**
3	Start the engine while listening to the starter motor turn. Is there a loud "whoop" it may sound like a siren if the engine is revved while the starter is engaged after the engine starts, but while the starter is still held in the engaged position?	Go to **Step 6**	Go to **Step 4**
4	Do you hear a "rumble", a "growl", or, in some cases, a "knock" as the starter is coasting down to a stop after starting the engine?	Go to **Step 7**	Go to **Step 5**
5	**IMPORTANT:** **This is often diagnosed as a starter drive gear hang-in or a weak solenoid.** When the engine is cranked, do you hear a high-pitched whine after the engine cranks and starts normally?	Go to **Step 8**	Go to **Step 7**
	Inspect the flywheel ring gear for the following:		

6	• Chipped gear teeth • Missing gear teeth • Milled teeth Is the flywheel bent or does it have damaged teeth?	Go to **Step 9**	Go to **Step 10**
7	1. Remove the starter motor. Refer to **Starter Motor Replacement (RPO L26)** or **Starter Motor Replacement (RPO LD8)**. 2. Inspect the starter motor bushings and clutch gear. Does the clutch gear have chipped or milled teeth or worn bushings?	Go to **Step 10**	Go to **Step 9**
8	Shim the starter motor away from the flywheel by adding shims between the starter motor and the engine block one at a time. Flywheel runout may make this noise appear to be intermittent. Did you complete the repair?	Go to **Step 11**	-
9	Replace the flywheel. Refer to **Engine Flywheel Replacement** for the 3.8L engine or **Engine Flywheel Removal** for the 4.6L engine. Did you complete the replacement?	Go to **Step 11**	-
10	Replace the starter motor. Refer to **Starter Motor Replacement (RPO L26)** or **Starter Motor Replacement (RPO LD8)**. Did you complete the replacement?	Go to **Step 11**	-
11	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to **Step 3**

REPAIR INSTRUCTIONS

BATTERY NEGATIVE CABLE DISCONNECTION AND CONNECTION

Removal Procedure

CAUTION: Refer to SIR Caution .

CAUTION: Before servicing any electrical component, the ignition and start switch must be in the OFF or LOCK position and all electrical loads must be OFF, unless instructed otherwise in these procedures. If a tool or equipment could easily come in contact with a live exposed electrical terminal, disconnect the negative battery cable. Failure to follow these precautions may cause personal injury and/or damage to the vehicle or its components.

IMPORTANT: The radio incorporates electronic memory for the clock and pre-selected radio stations, reprogramming is not necessary.

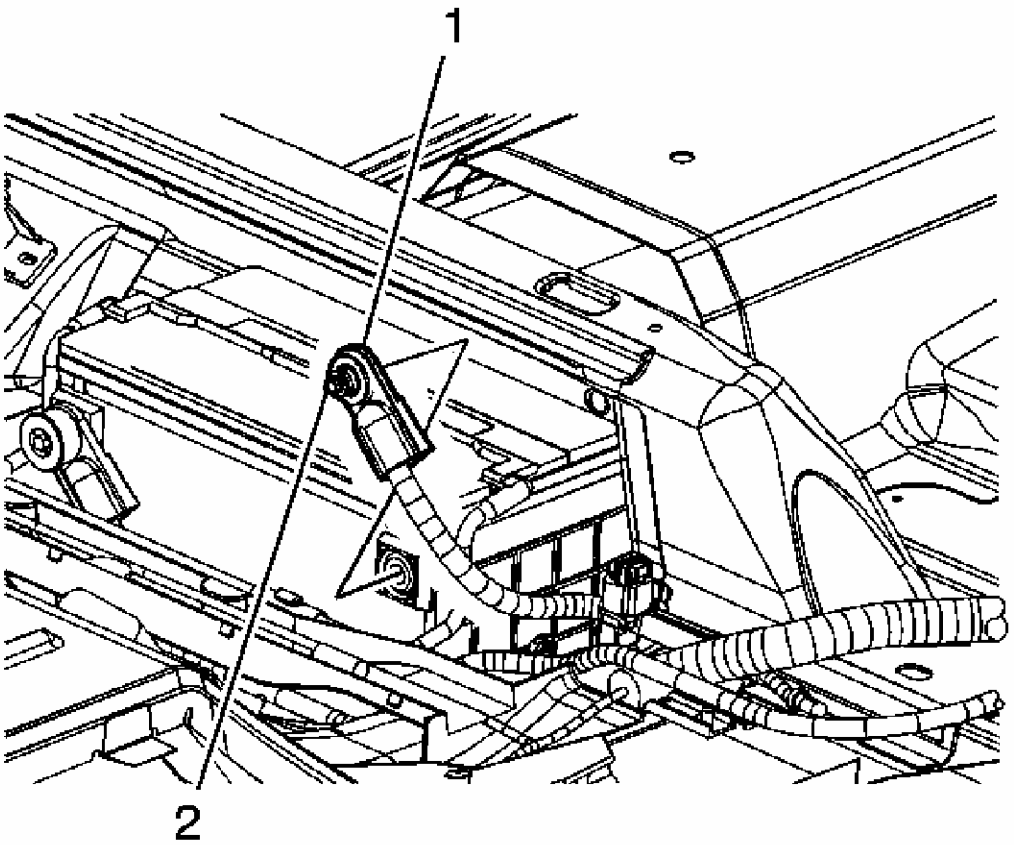


Fig. 11: Locating Battery
Courtesy of GENERAL MOTORS CORP.

1. Ensure all lamps and accessories are OFF.
2. Ensure the ignition switch is in the OFF position.
3. Remove the rear seat cushion. Refer to **Rear Seat Cushion Replacement** .
4. Loosen the negative battery cable bolt (2).
5. Separate the negative battery cable (1) from the battery.

Installation Procedure

IMPORTANT: Clean any existing oxidation from the contact face of the battery and battery cable using a wire brush prior to installing the battery cable to the battery.

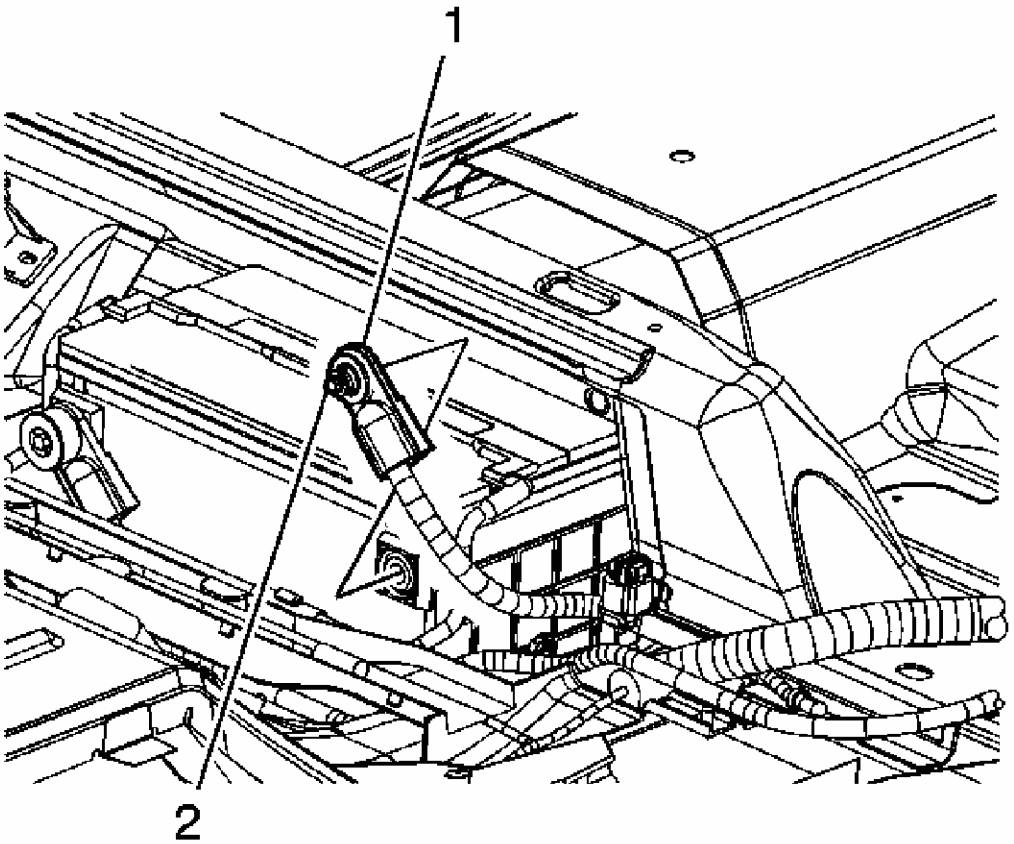


Fig. 12: Locating Battery
Courtesy of GENERAL MOTORS CORP.

1. Position the negative battery cable (1) to the battery.

NOTE: **Refer to Fastener Notice .**

2. Tighten the negative battery cable bolt (2).

Tighten: Tighten the bolt to 17 N.m (13 lb ft).

3. Install the rear seat cushion. Refer to **Rear Seat Cushion Replacement** .

BATTERY CURRENT SENSOR REPLACEMENT

Removal Procedure

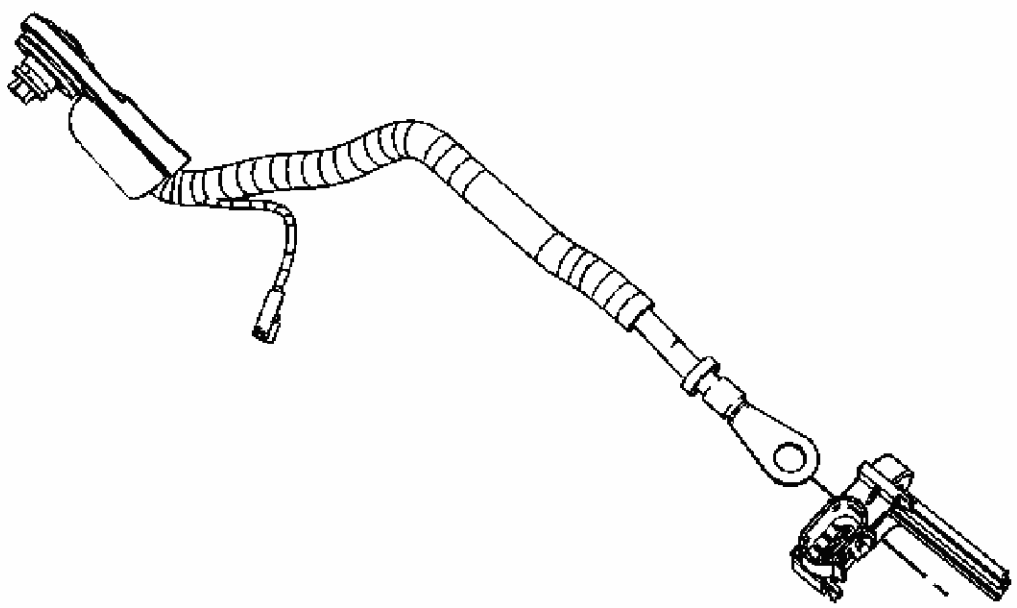


Fig. 13: Identifying Battery Current Sensor
Courtesy of GENERAL MOTORS CORP.

1. Remove the negative battery cable. Refer to **Battery Negative Cable Replacement**.
2. Remove the tape securing the battery current sensor to the negative battery cable.
3. Remove the battery current sensor.

Installation Procedure

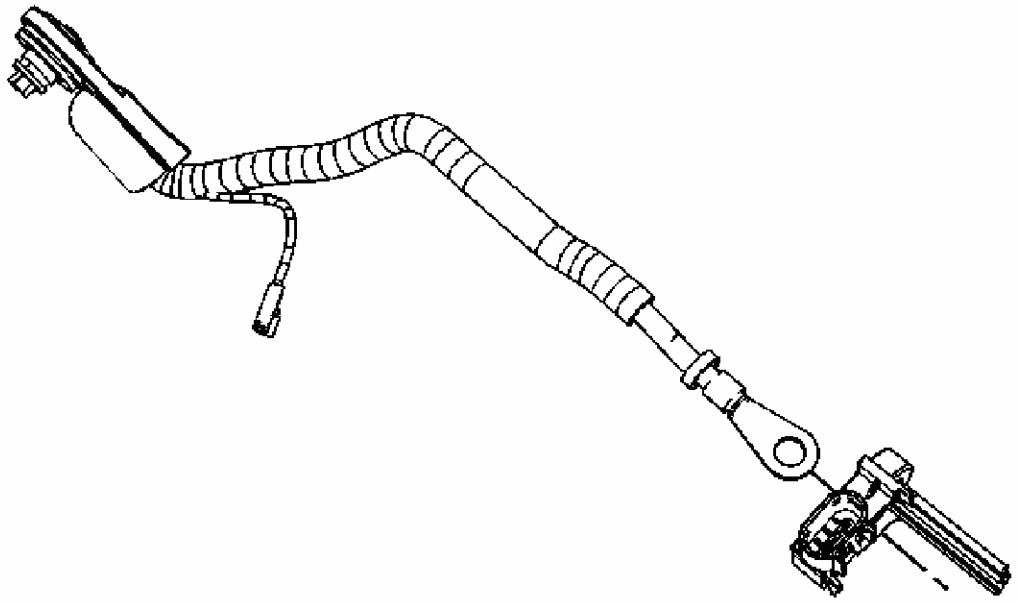


Fig. 14: Identifying Battery Current Sensor
Courtesy of GENERAL MOTORS CORP.

1. Install the battery current sensor by passing the ground end of the negative cable through the sensor.
2. Wrap electrical tape around the battery current sensor in order to secure the sensor to the negative battery cable.
3. Install the negative battery cable. Refer to **Battery Negative Cable Replacement**.

BATTERY NEGATIVE CABLE REPLACEMENT

Removal Procedure

IMPORTANT:

- **Always use replacement cables that are of the same type, diameter and length of the cables that you are replacing.**
- **Always route the replacement cable the same way as the original cable.**

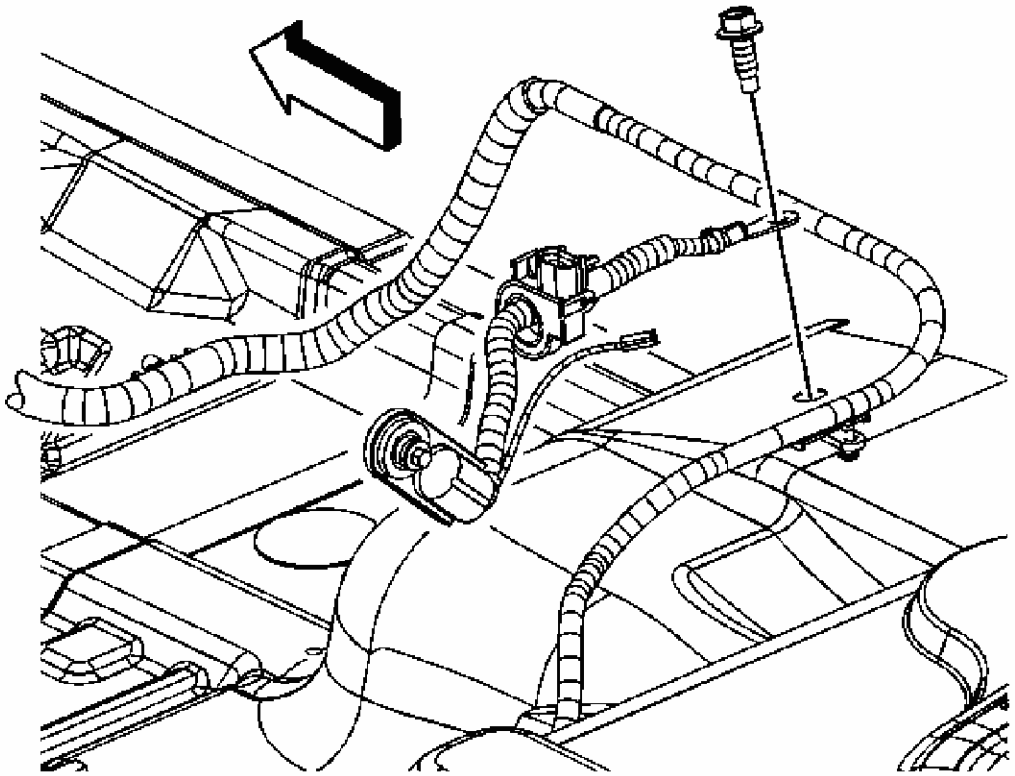


Fig. 15: Removing/Installing Negative Battery Cable
Courtesy of GENERAL MOTORS CORP.

1. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection**.
2. Disconnect the body harness electrical connector from the negative battery cable electrical connector.
3. Disconnect the body harness electrical connector from the battery current sensor.
4. Remove the negative battery cable ground bolt.
5. Remove the negative battery cable.

Installation Procedure

IMPORTANT: When installing the negative battery cable, ensure that the cable eyelet is installed with the flat side down. Keep the crimped side facing upward.

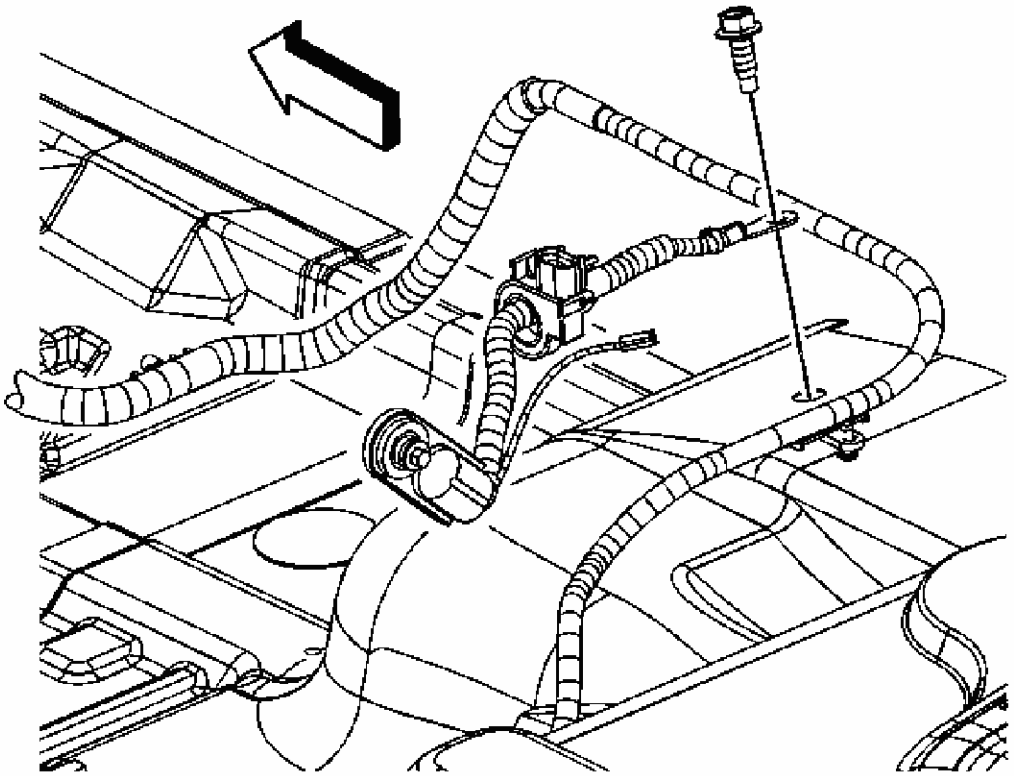


Fig. 16: Removing/Installing Negative Battery Cable
Courtesy of GENERAL MOTORS CORP.

1. Place the negative battery cable eyelet over the hole in the floor pan.

NOTE: **Refer to Fastener Notice .**

2. Install the negative battery cable ground bolt.

   Tighten: Tighten the bolt to 36 N.m (27 lb ft).

3. Connect the body harness electrical connector to the battery current sensor.
4. Connect the body harness electrical connector to the negative battery cable electrical connector.
5. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection**.

BATTERY POSITIVE CABLE REPLACEMENT

Removal Procedure

IMPORTANT:

- **Always use replacement cables that are of the same type, diameter and length of the cables that you are replacing.**
- **Always route the replacement cable the same way as the original cable.**

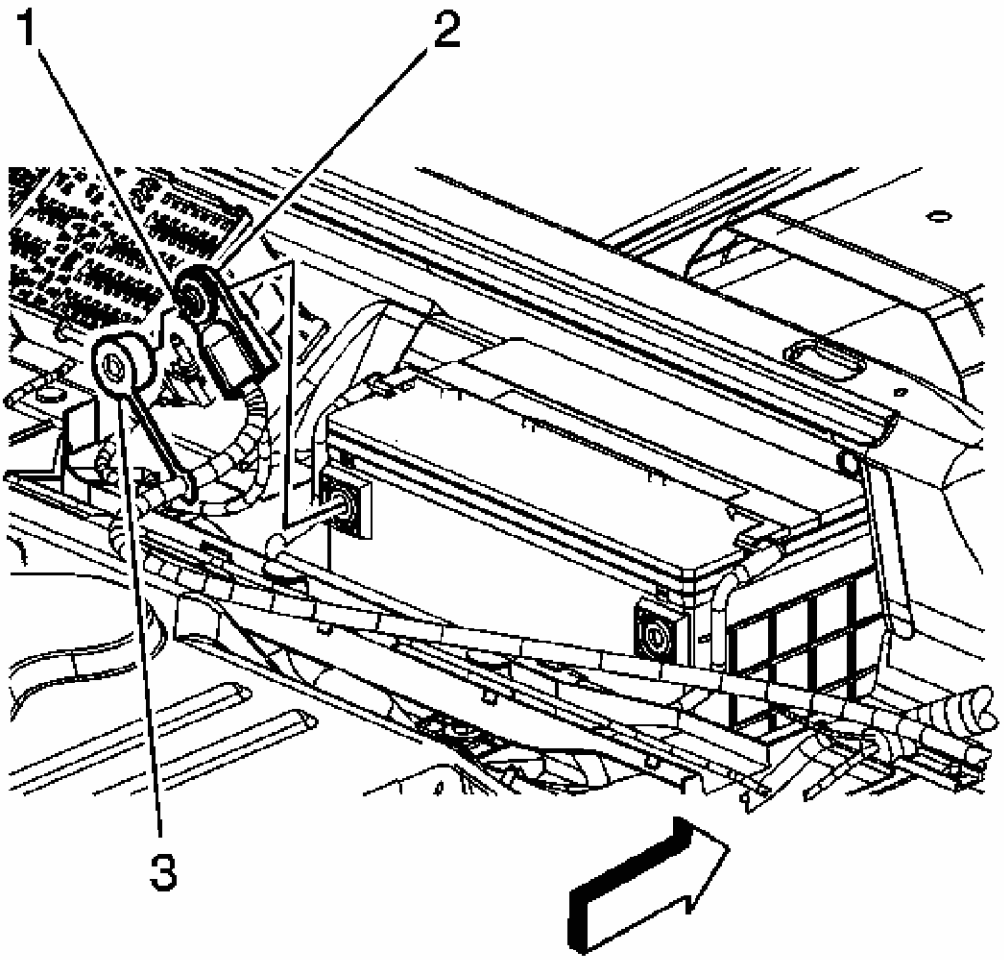


Fig. 17: Removing/Installing Positive Battery Cable Cover
Courtesy of GENERAL MOTORS CORP.

1. Remove the surge tank. Refer to **Radiator Surge Tank Replacement (LD8)** .
2. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection**.

3. Remove the carpet. Refer to **Front Floor Panel Carpet Replacement** and **Rear Floor Panel Carpet Replacement** .
4. Unsnap the positive battery cable cover (3) and reposition.
5. Loosen the positive battery cable bolt (1).
6. Separate the positive battery cable (2) from the battery.

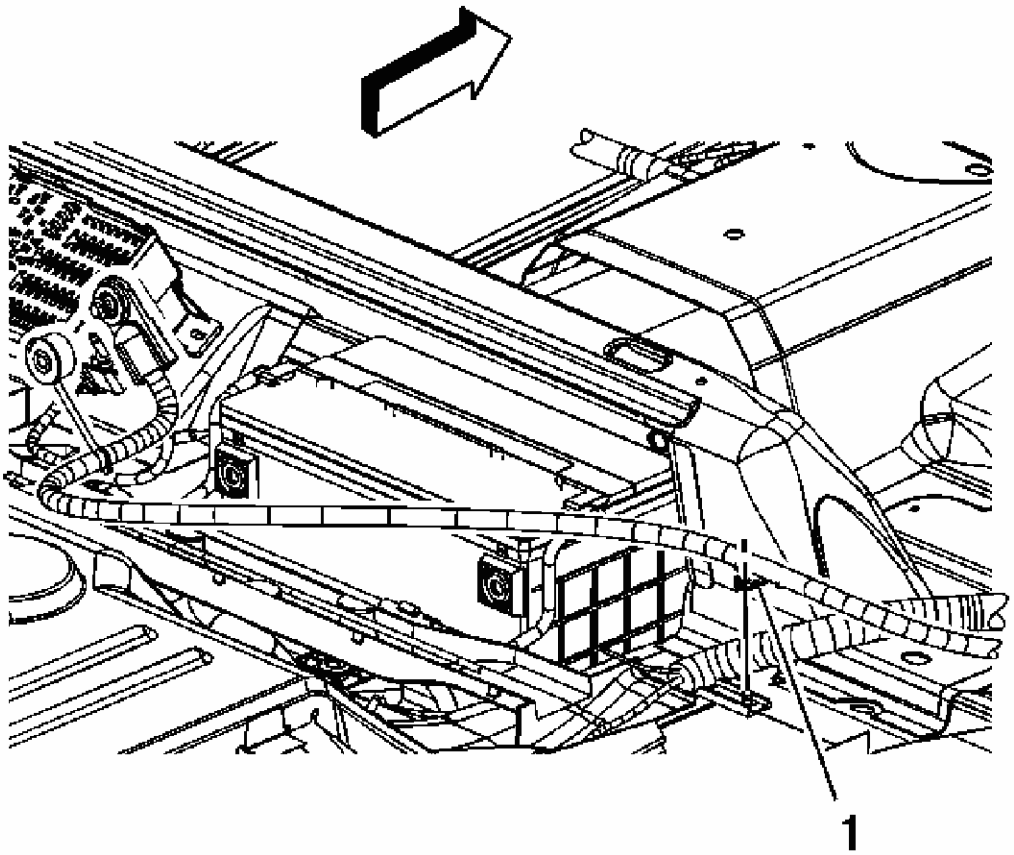


Fig. 18: Identifying Battery Cable Retainer
Courtesy of GENERAL MOTORS CORP.

7. Remove the positive battery cable retainer (1) from the floor pan stud.

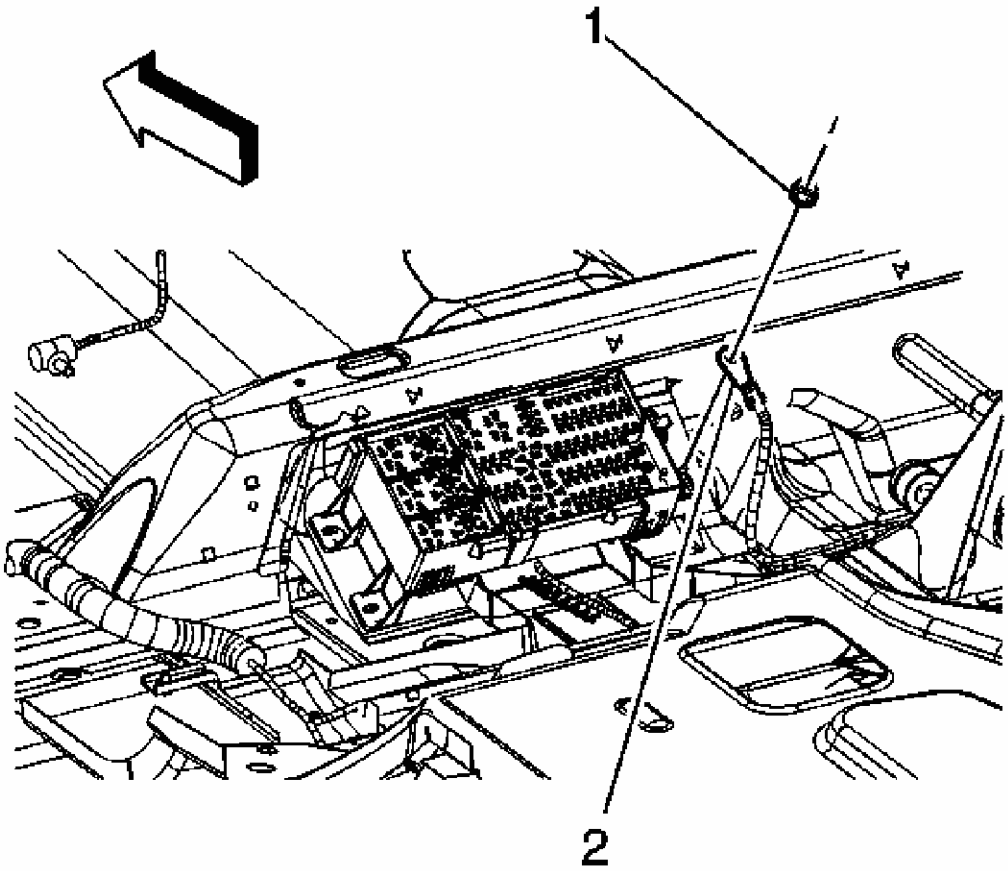


Fig. 19: Removing/Installing Positive Battery Cable Nut At Junction Block Stud
Courtesy of GENERAL MOTORS CORP.

8. Remove the positive battery cable nut (1) from the junction block stud.
9. Remove the positive battery cable terminal (2) from the junction block stud.

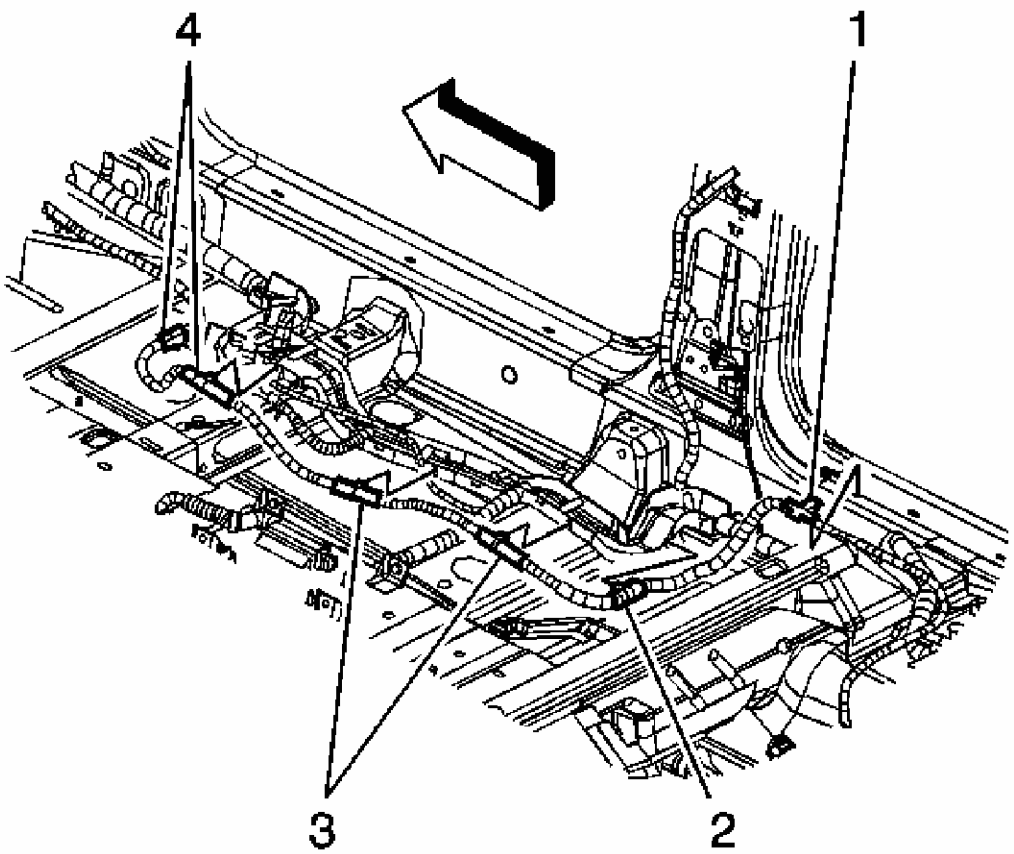


Fig. 20: Removing/Installing Positive Battery Cable Retainer
Courtesy of GENERAL MOTORS CORP.

10. Remove the positive battery cable retainer (1) from the rocker panel.
11. Remove the positive battery cable retainers (2, 3 and 4) from the body harness channel.

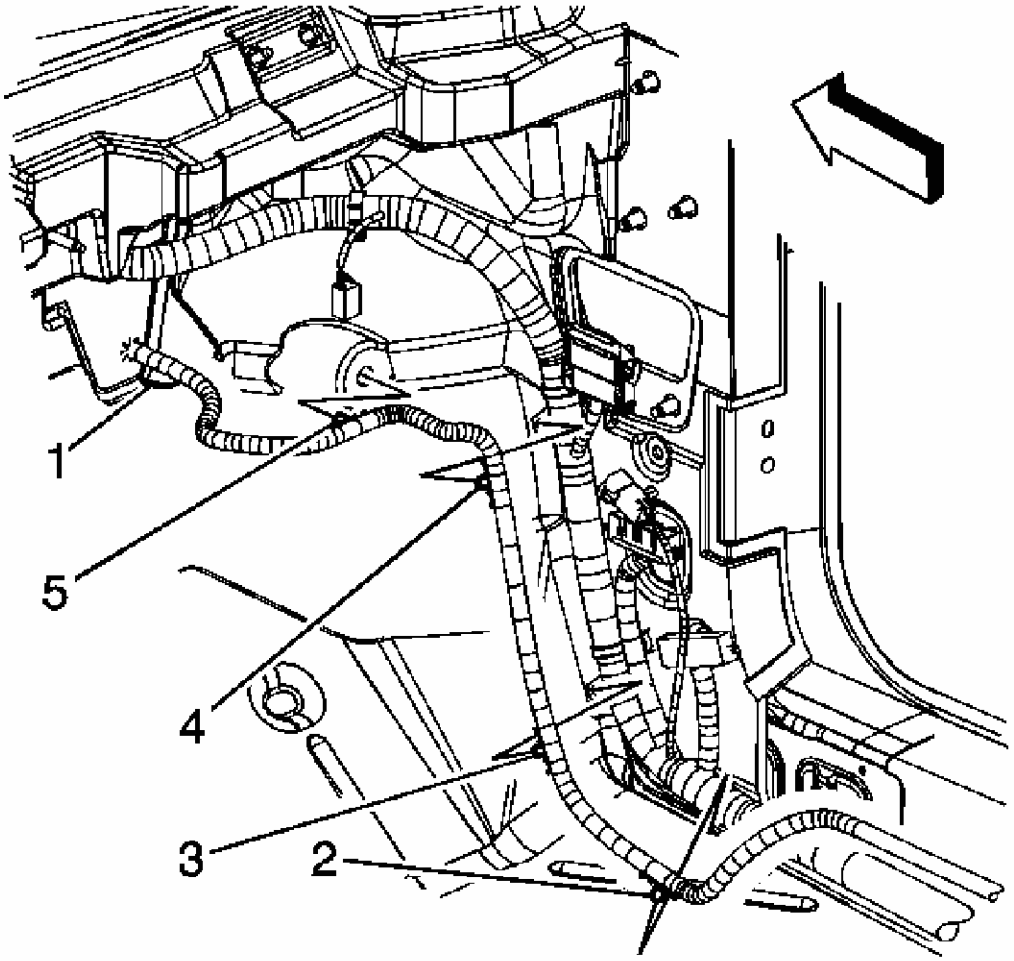


Fig. 21: Identifying Positive Battery Cable Clips
Courtesy of GENERAL MOTORS CORP.

12. Remove the positive battery cable clips (2, 3 and 4) from the body harness retainers.
13. Remove the positive battery cable clip (5) from the dash mat.
14. Reposition the dash mat flap (1).

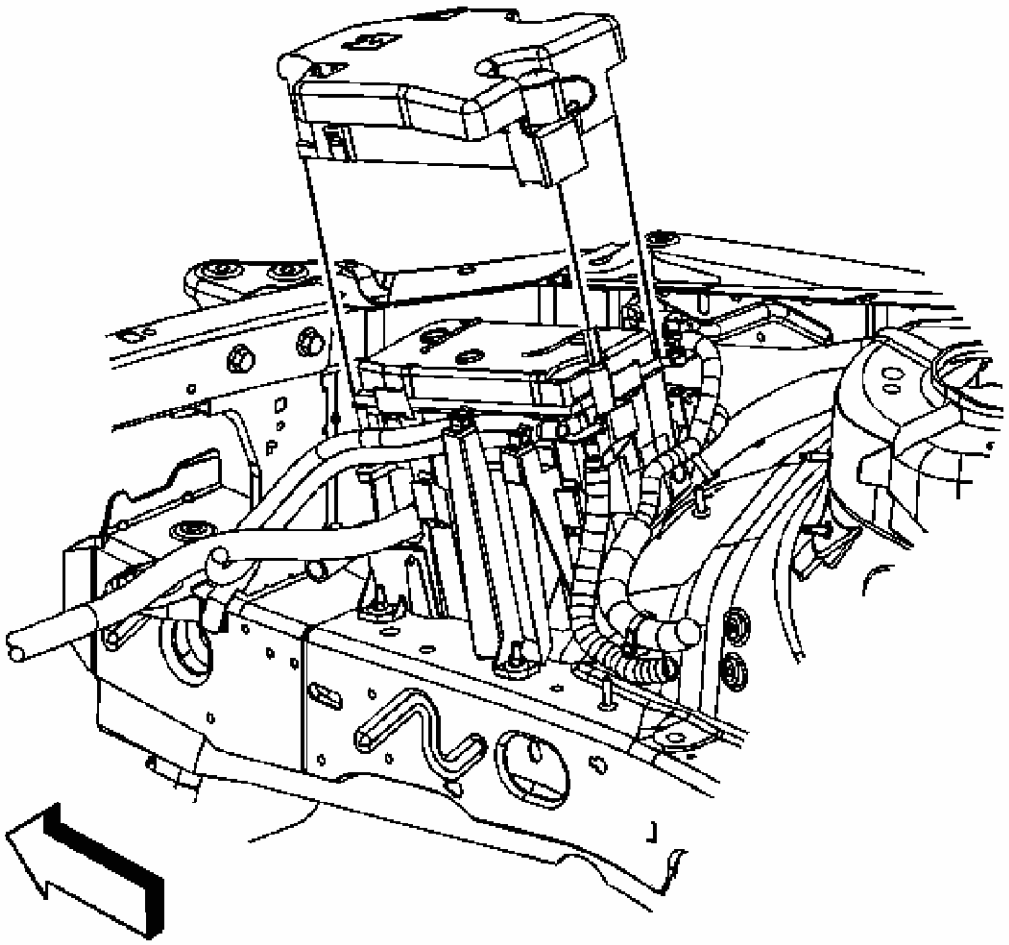


Fig. 22: View Of Junction Block Cover
Courtesy of GENERAL MOTORS CORP.

15. From under the hood, disengage the junction block cover lock tabs.
16. Remove the junction block cover.

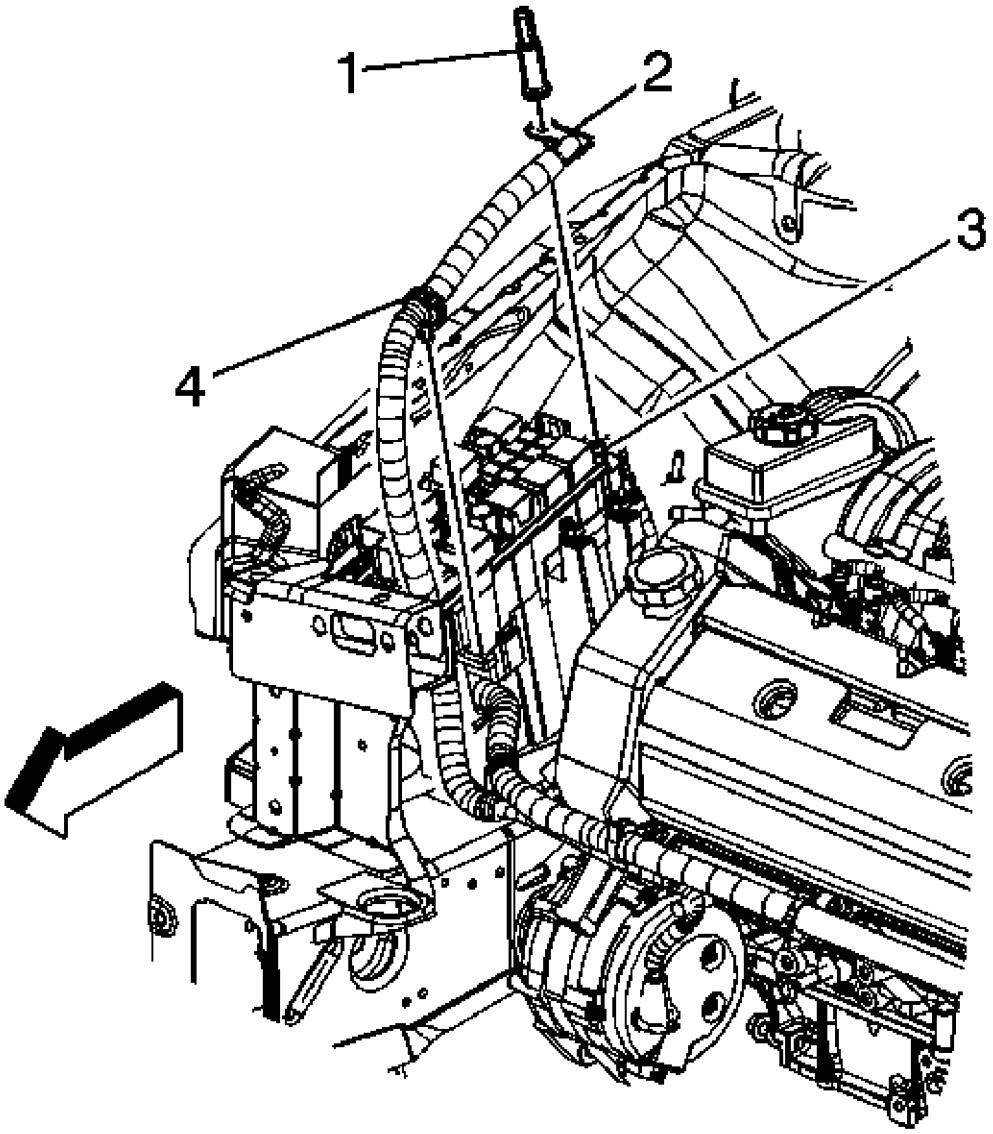


Fig. 23: Identifying Starter Solenoid Cable To Bussed Electrical Center
Courtesy of GENERAL MOTORS CORP.

17. Remove the nut (1) securing the starter solenoid cable to the bussed electrical center (BEC).
18. Remove the starter solenoid cable from the BEC stud.

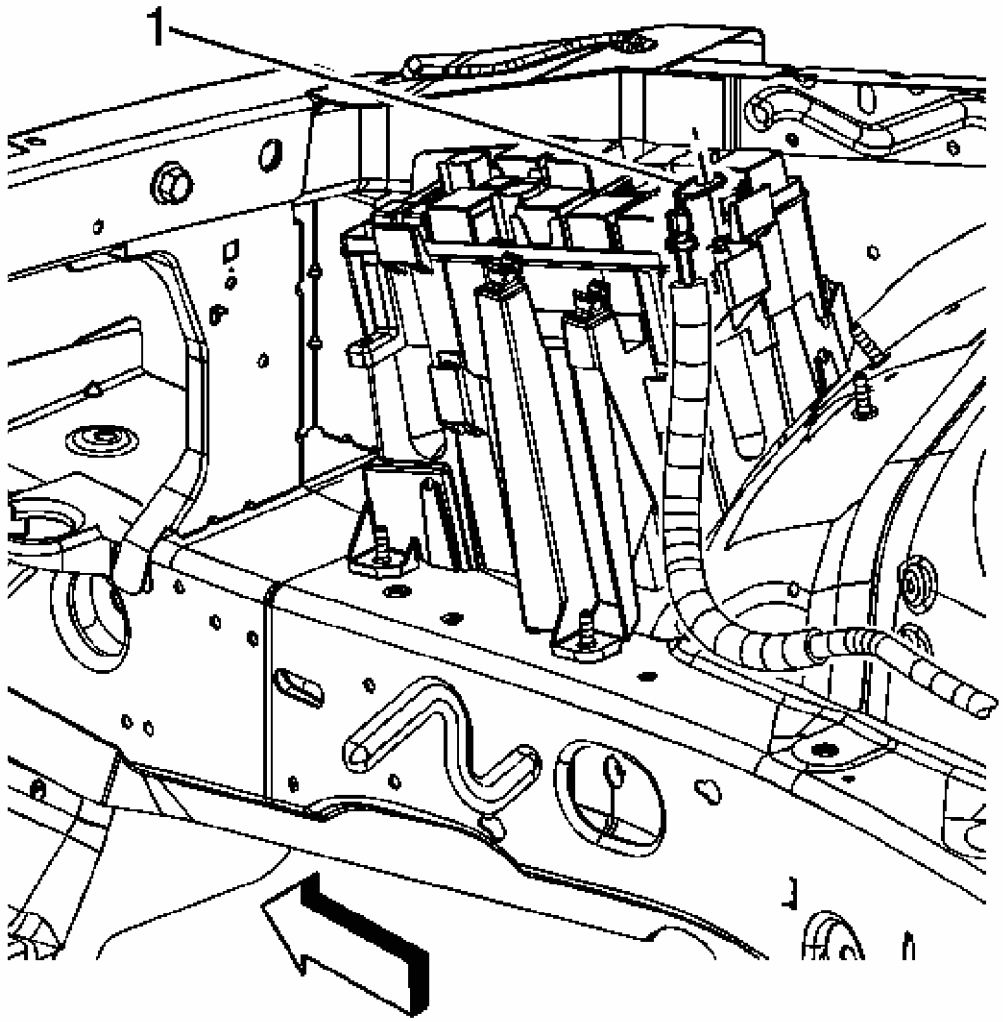


Fig. 24: Identifying Positive Battery Cable & BEC Stud
Courtesy of GENERAL MOTORS CORP.

19. Remove the positive battery cable (1) from the BEC stud.

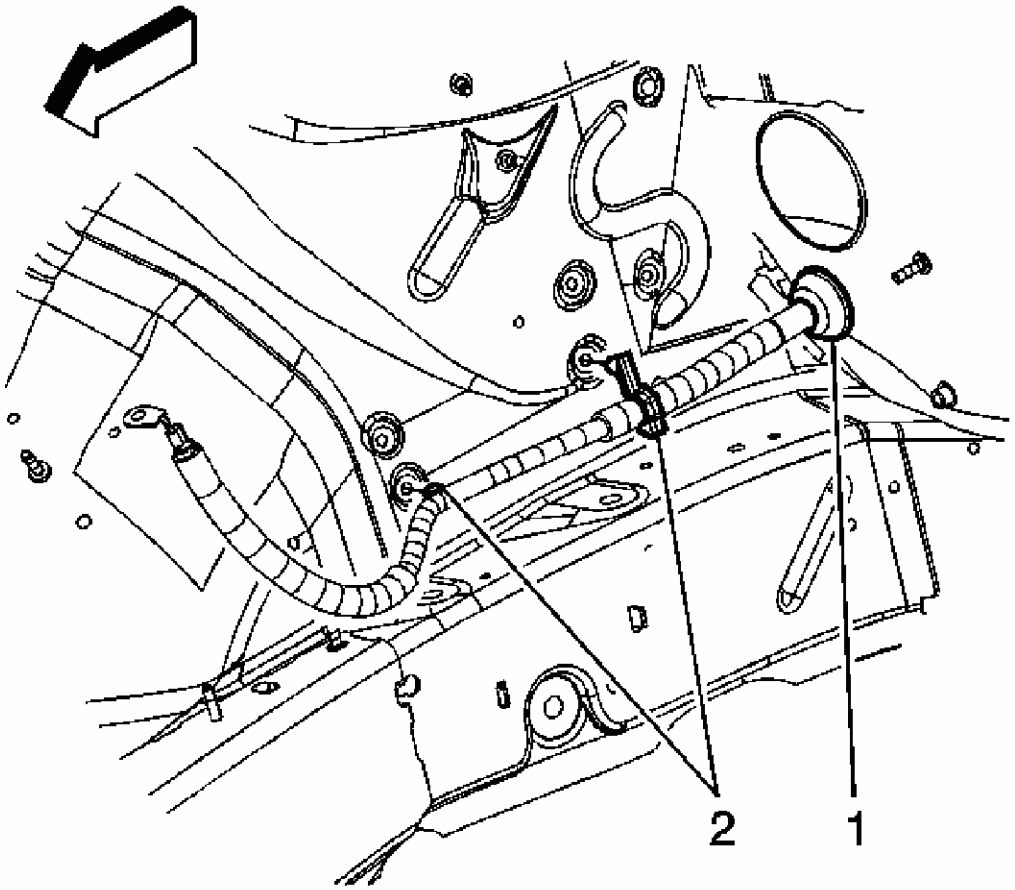


Fig. 25: Removing/Installing Positive Battery Clips
Courtesy of GENERAL MOTORS CORP.

20. Remove the positive battery clips (2) from the side engine compartment.
21. Carefully unseat the positive battery cable grommet (1) from the front of dash.
22. From inside the vehicle, carefully remove the positive battery cable by pulling the cable through the front of dash and out of the vehicle.

Installation Procedure

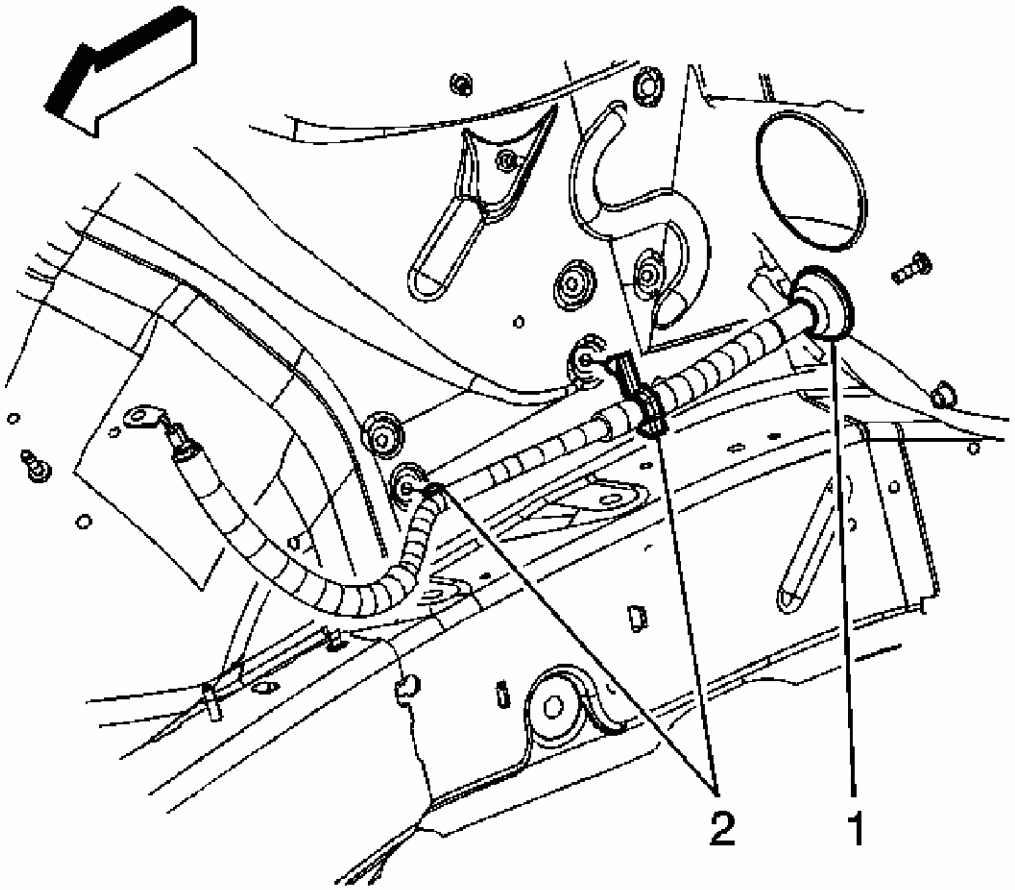


Fig. 26: Removing/Installing Positive Battery Clips
Courtesy of GENERAL MOTORS CORP.

1. From inside the vehicle, carefully lay out the positive battery cable and route the front portion through the front of dash.
2. From under the hood, carefully seat the positive battery cable grommet (1) to the front of dash.
3. Install the positive battery clips (2) to the side engine compartment.

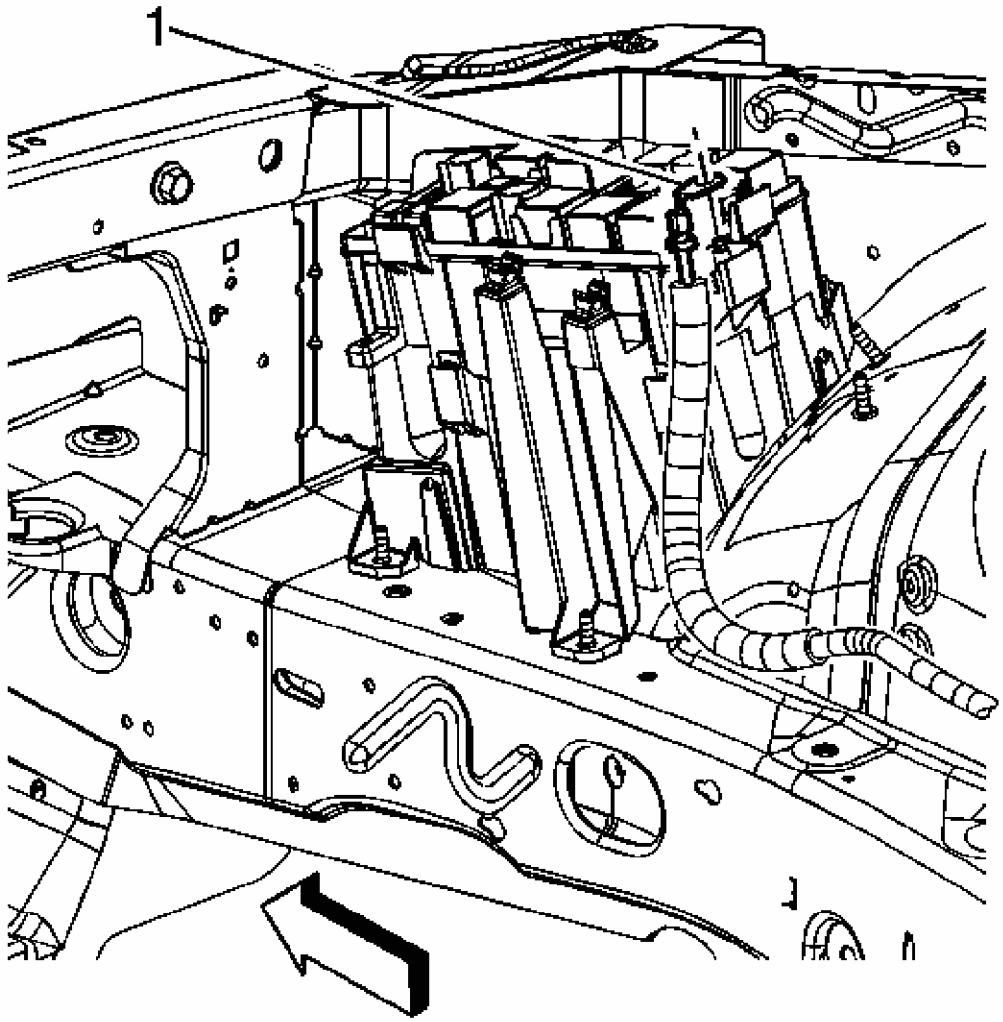


Fig. 27: Identifying Positive Battery Cable & BEC Stud
Courtesy of GENERAL MOTORS CORP.

4. Install the positive battery cable (1) to the BEC stud.

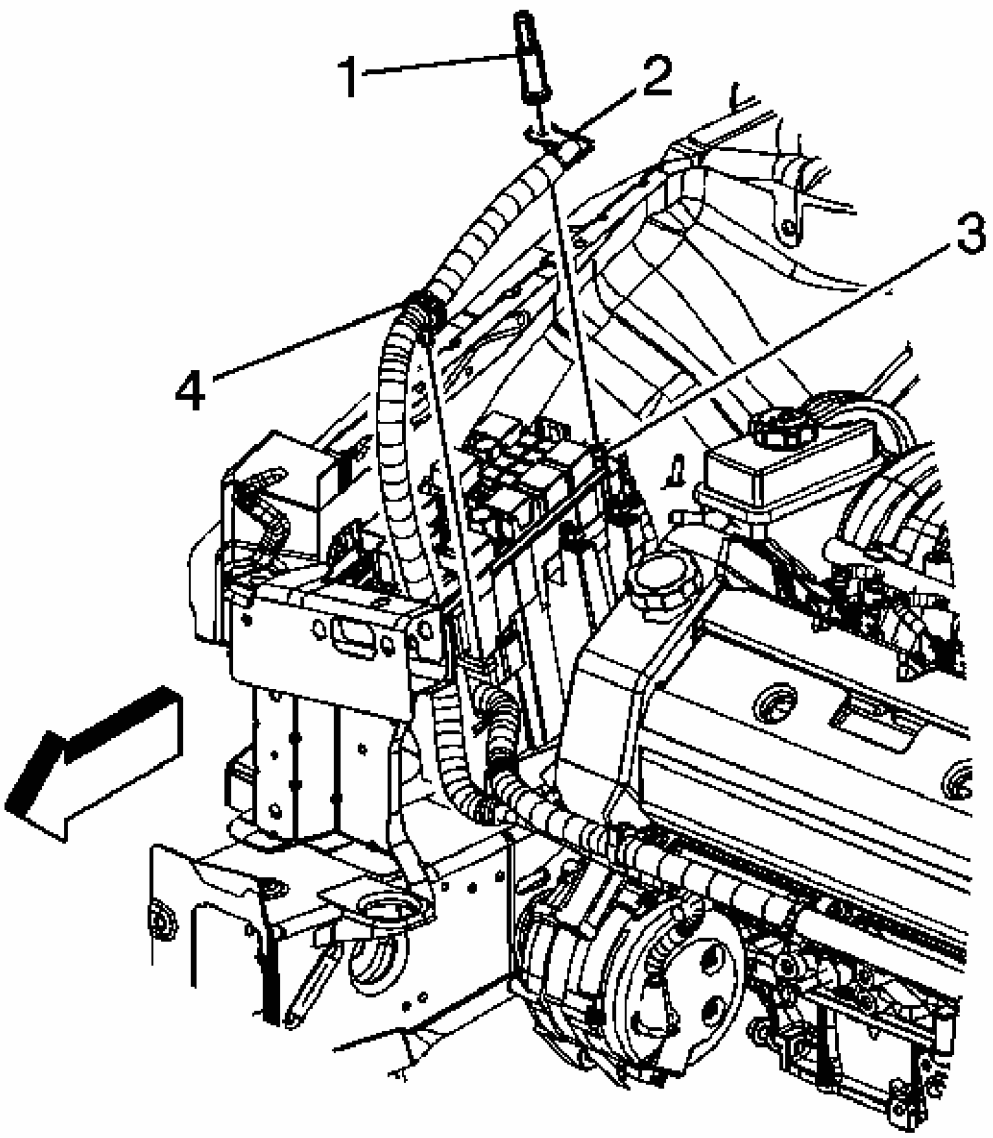


Fig. 28: Identifying Starter Solenoid Cable To Bussed Electrical Center
Courtesy of GENERAL MOTORS CORP.

5. Install the starter solenoid cable to the BEC stud.

NOTE: **Refer to Fastener Notice .**

6. Install the nut (1) securing the starter solenoid cable to the BEC.

Tighten: Tighten the nut to 15 N.m (11 lb ft).

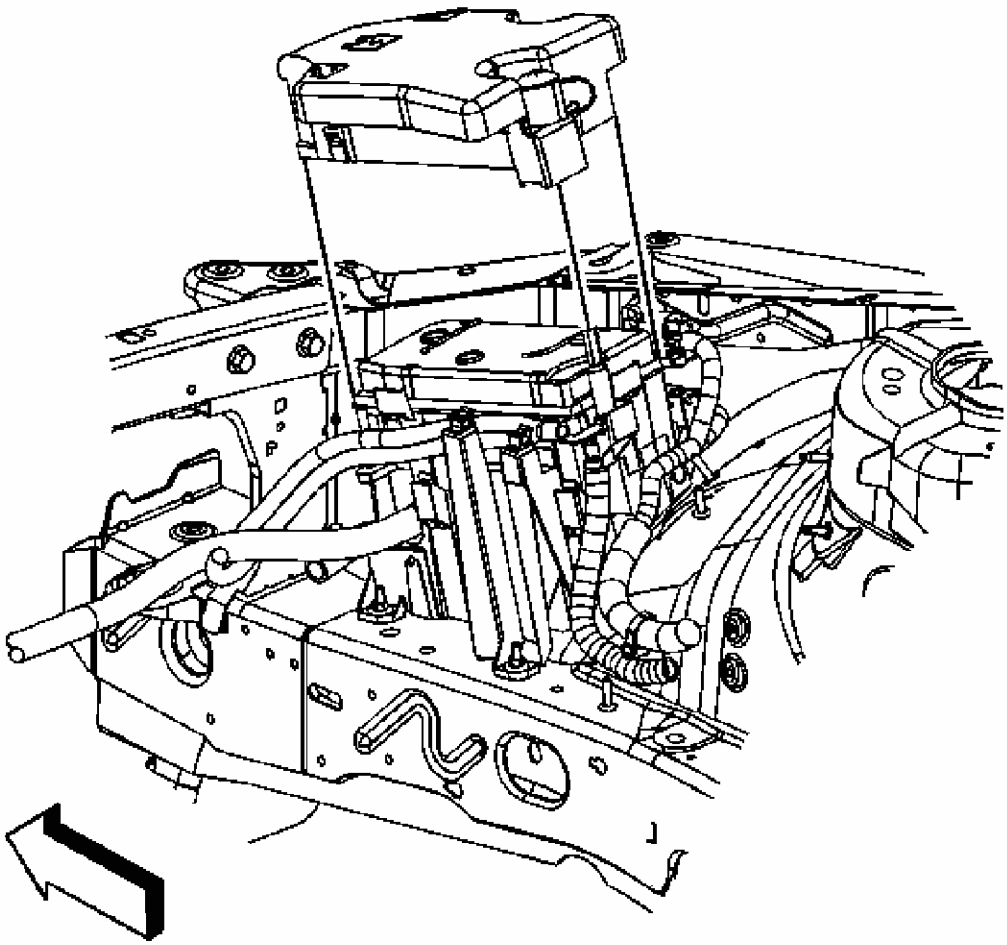


Fig. 29: View Of Junction Block Cover
Courtesy of GENERAL MOTORS CORP.

7. Install the junction block cover.

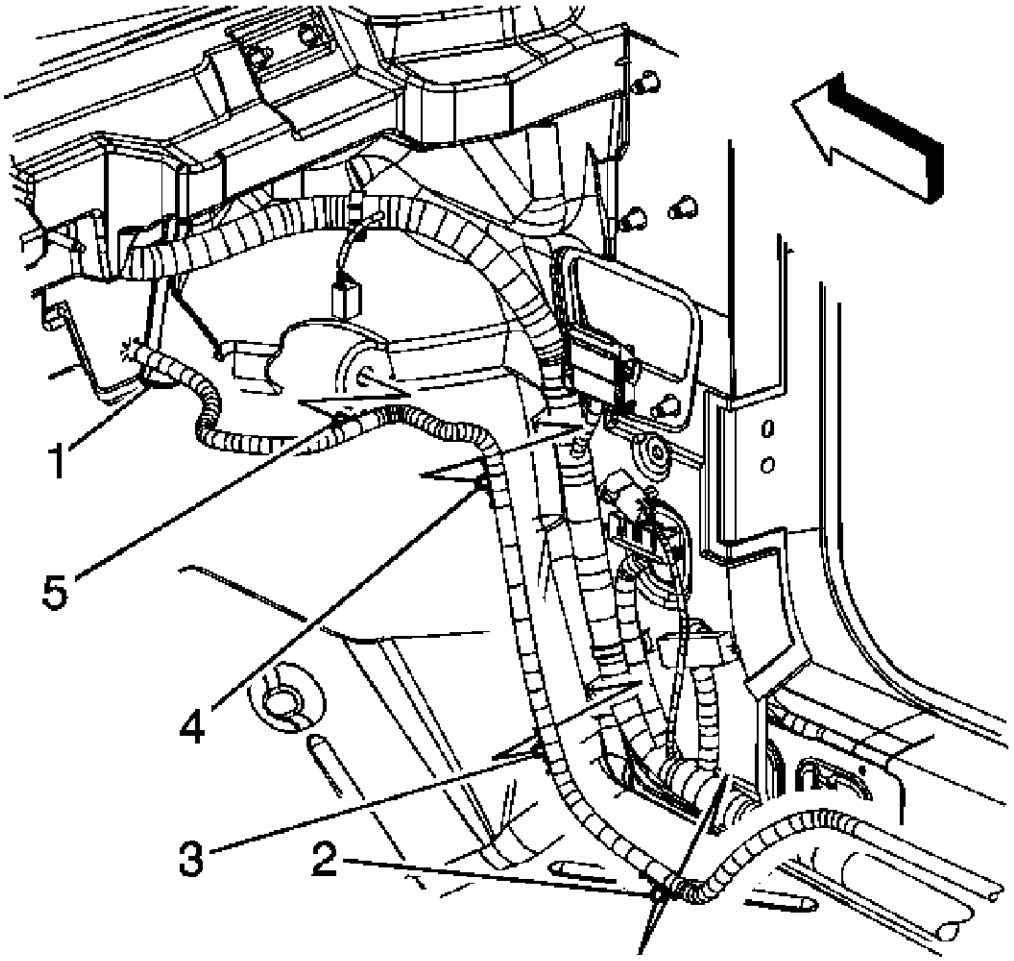


Fig. 30: Identifying Positive Battery Cable Clips
Courtesy of GENERAL MOTORS CORP.

8. From inside the vehicle, position the dash mat flap (1) into place.
9. Install the positive battery cable clip (5) to the dash mat.
10. Install the positive battery cable clips (2, 3 and 4) to the body harness retainers.

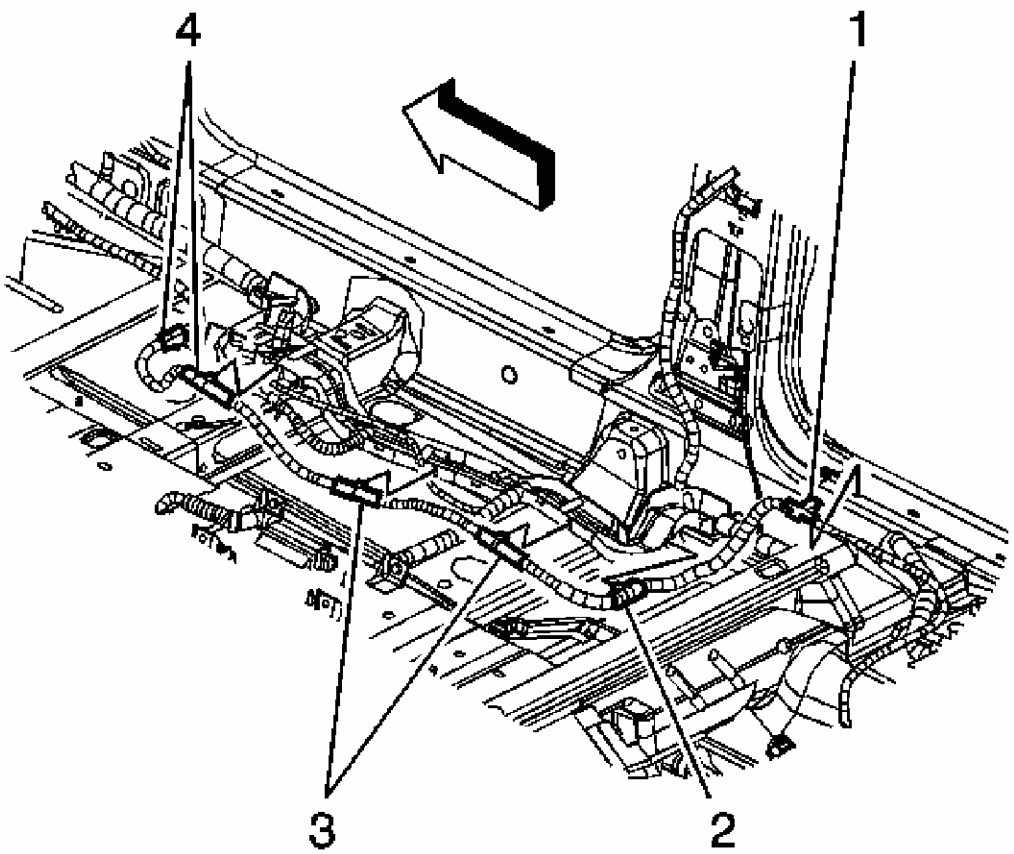


Fig. 31: Removing/Installing Positive Battery Cable Retainer
Courtesy of GENERAL MOTORS CORP.

11. Install the positive battery cable retainers (2, 3 and 4) to the body harness channel.
12. Install the positive battery cable retainer (1) to the rocker panel.

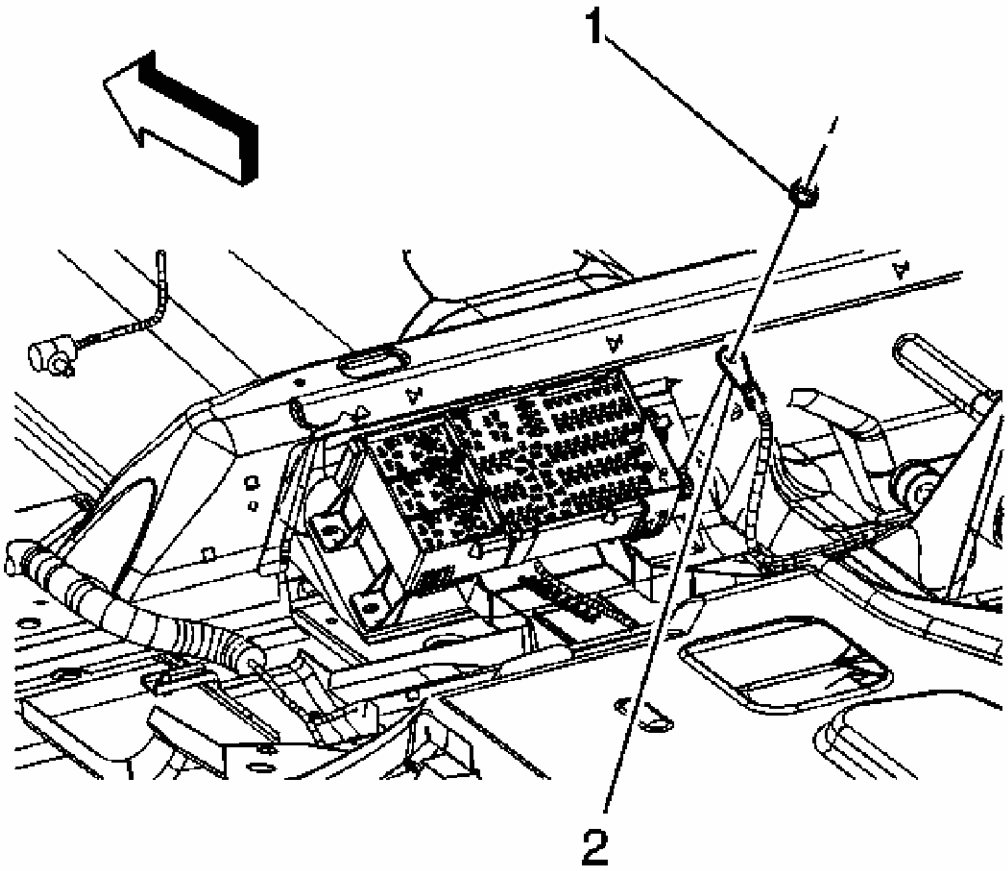


Fig. 32: Removing/Installing Positive Battery Cable Nut At Junction Block Stud
Courtesy of GENERAL MOTORS CORP.

13. Install the positive battery cable terminal (2) to the junction block stud.
14. Install the positive battery cable nut (1) to the junction block stud.

Tighten: Tighten the nut to 15 N.m (11 lb ft).

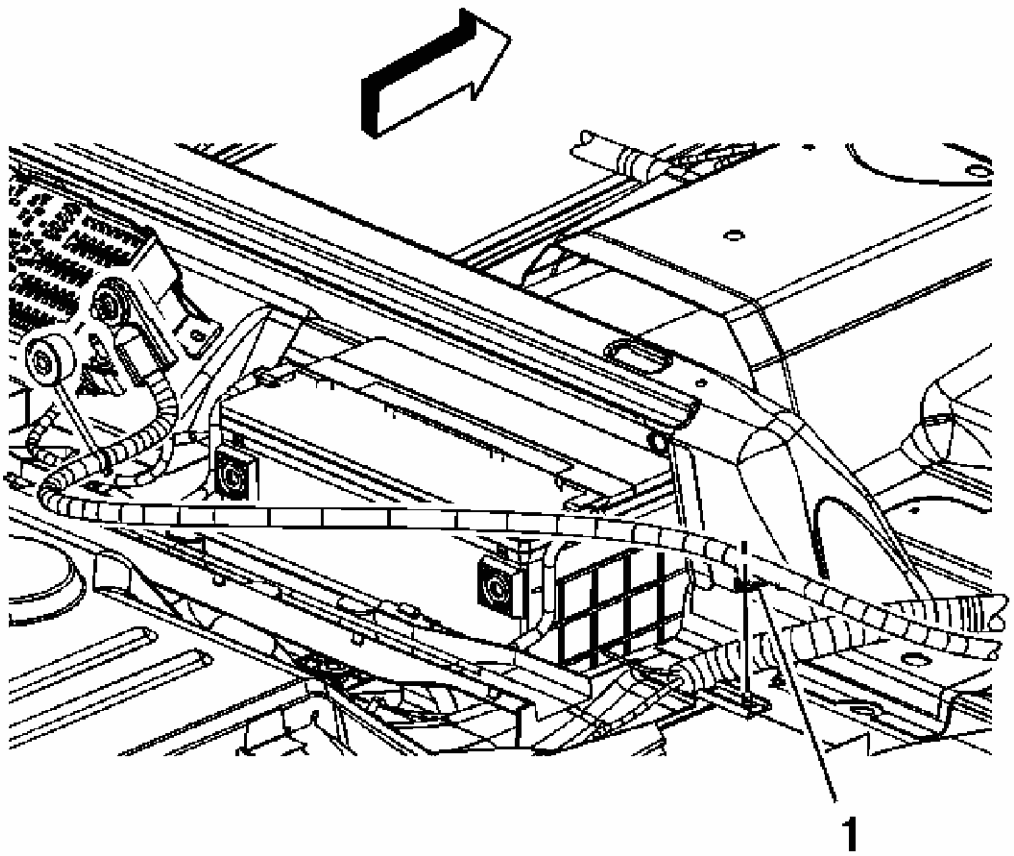


Fig. 33: Identifying Battery Cable Retainer
Courtesy of GENERAL MOTORS CORP.

15. Install the positive battery cable retainer (1) to the floor pan stud.

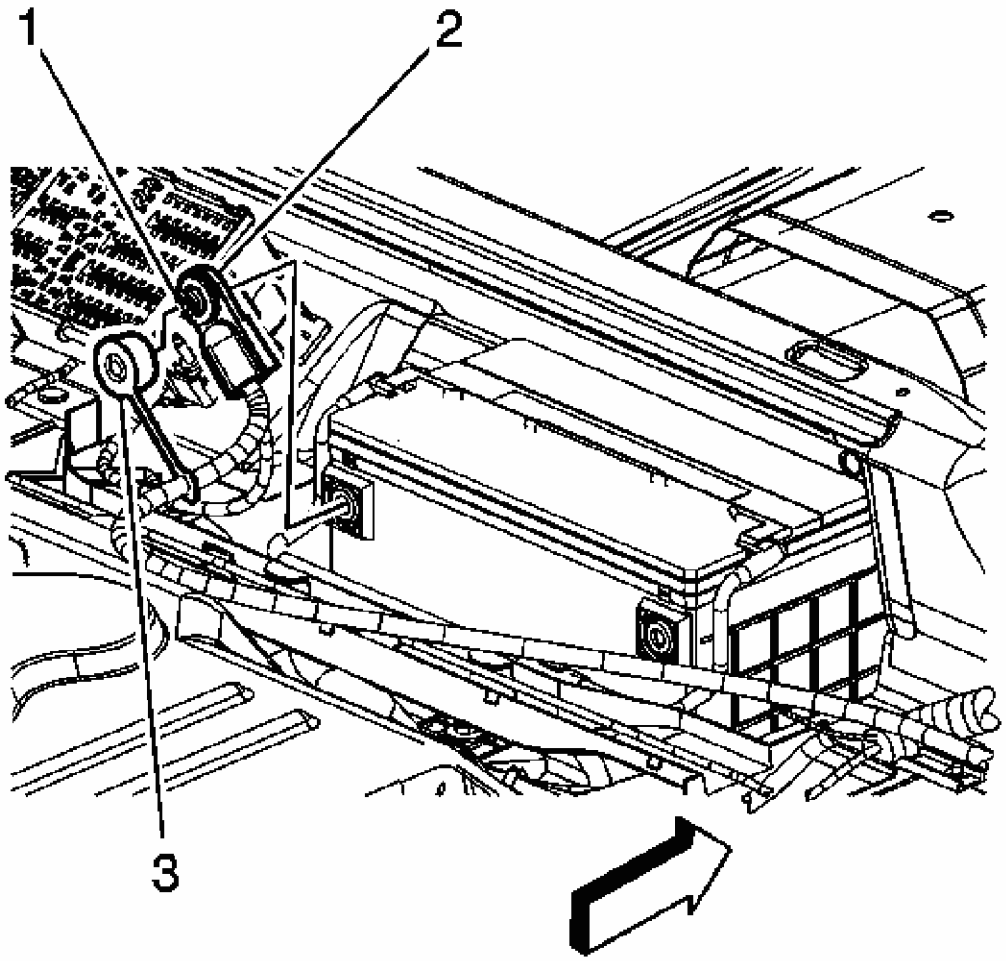


Fig. 34: Removing/Installing Positive Battery Cable Cover
Courtesy of GENERAL MOTORS CORP.

16. Position the positive battery cable (2) to the battery.
17. Tighten the positive battery cable bolt (1).

    Tighten: Tighten the bolt to 17 N.m (13 lb ft).

18. Snap the positive battery cable cover (3) closed.
19. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection**.
20. Install the carpet. Refer to **Front Floor Panel Carpet Replacement** and **Rear Floor Panel Carpet Replacement** .

21. Install the surge tank. Refer to **Radiator Surge Tank Replacement (LD8)** .

STARTER SOLENOID CABLE REPLACEMENT (RPO L26)

Removal Procedure

IMPORTANT:

- Always use replacement cables that are of the same type, diameter and length of the cables that you are replacing.
- Always route the replacement cable the same way as the original cable.

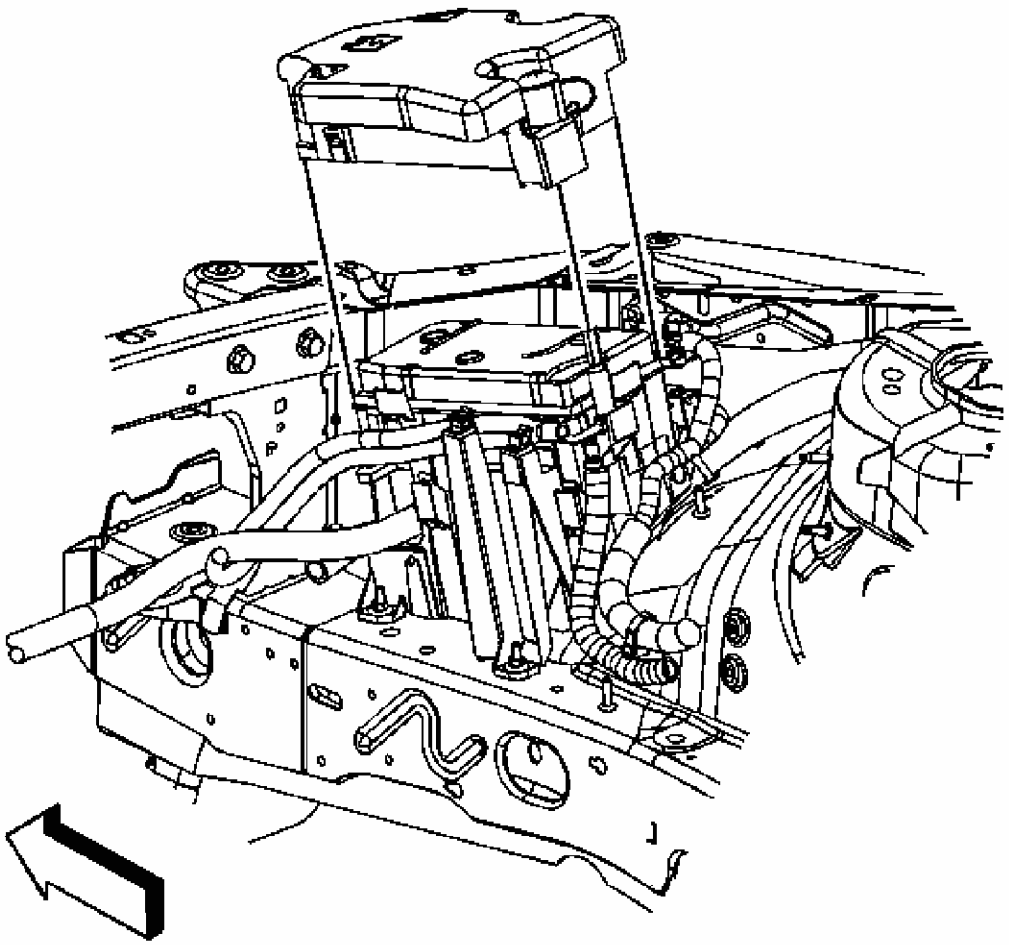


Fig. 35: View Of Junction Block Cover
Courtesy of GENERAL MOTORS CORP.

1. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection**.
2. Remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement** .
3. Disengage the junction block cover lock tabs.
4. Remove the junction block cover.

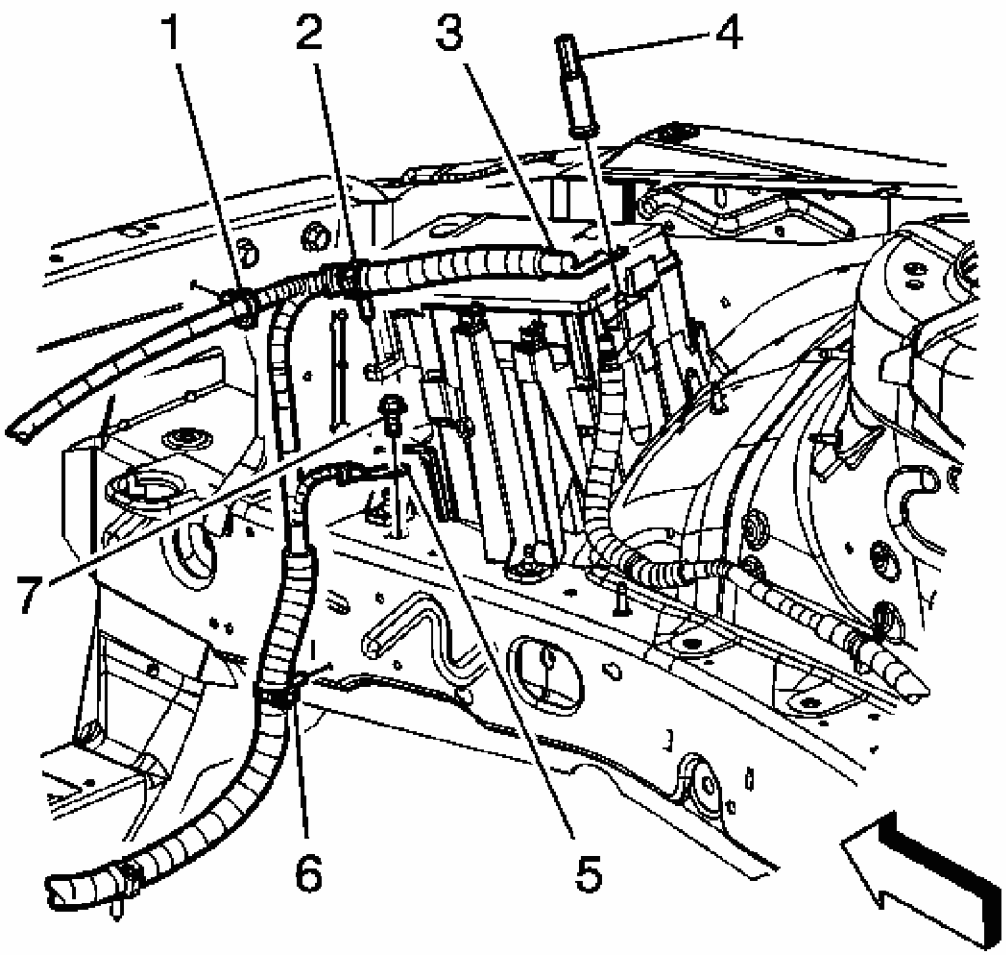


Fig. 36: Identifying Starter Cable & Retaining Nut
Courtesy of GENERAL MOTORS CORP.

5. Remove the nut (4) securing the starter cable (3) to the bussed electrical center (BEC).
6. Remove the starter cable from the BEC stud.
7. Remove the starter cable bolt (7) from the side rail.
8. Reposition the starter cable terminal (5) from the side rail.

9. Remove the starter cable retainer (1) from the tie bar.
10. Remove the starter cable retainer (2) from the BEC housing.
11. Remove the starter cable retainer (6) from the side rail.

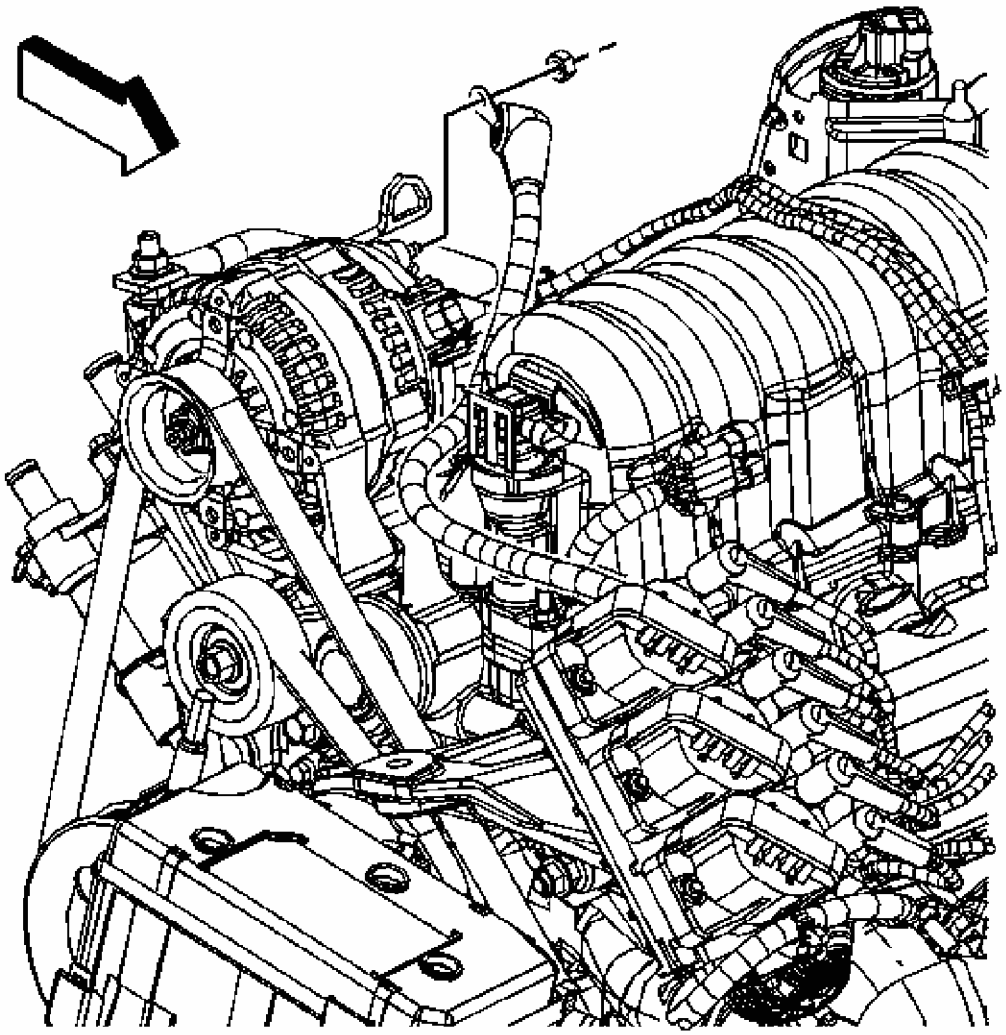


Fig. 37: Removing/Installing Generator Terminal Nut
Courtesy of GENERAL MOTORS CORP.

12. Reposition the starter cable boot.
13. Remove the generator terminal nut.
14. Remove the starter cable from the generator.

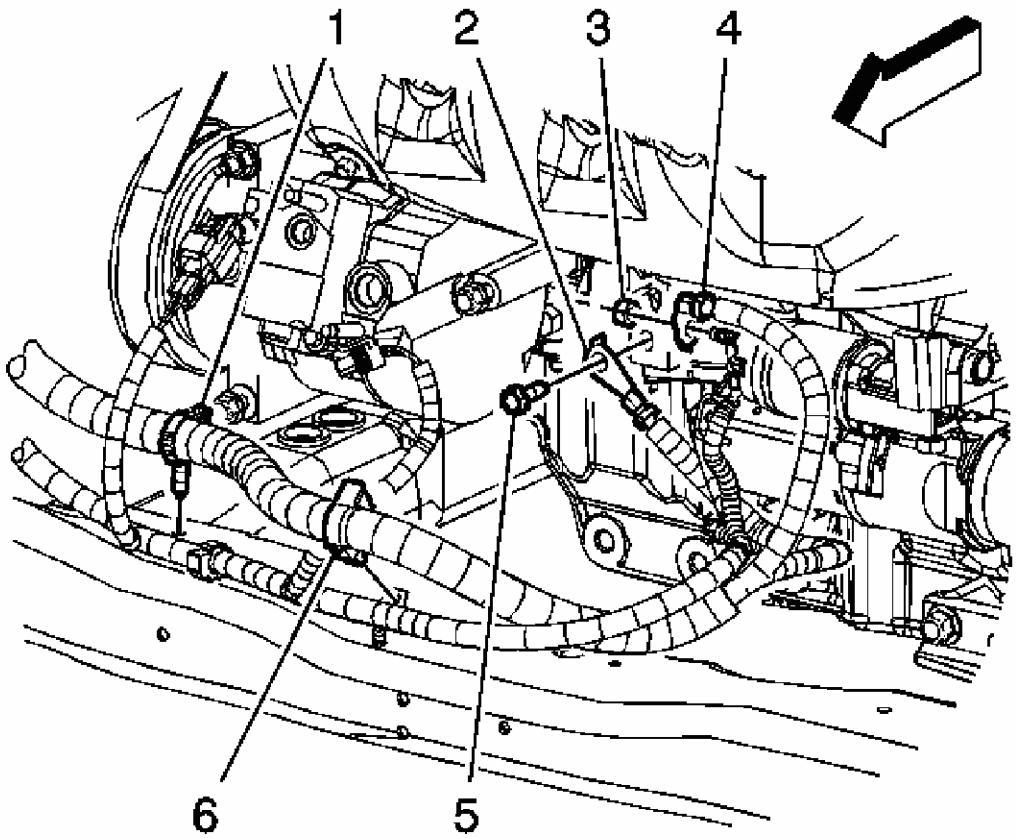


Fig. 38: Identifying Starter Solenoid & Starter Motor Cable Terminals
Courtesy of GENERAL MOTORS CORP.

15. Remove the front compartment sight shield. Refer to **Front Compartment Sight Shields Replacement** .
16. Remove the "BAT" terminal nut (3) from the starter.
17. Remove the starter solenoid cable terminal (4) from the starter.
18. Remove the starter cable ground bolt (5) and reposition the starter cable ground.
19. Remove the starter cable retainers (1, 6) from the frame.
20. Remove the starter cable.

Installation Procedure

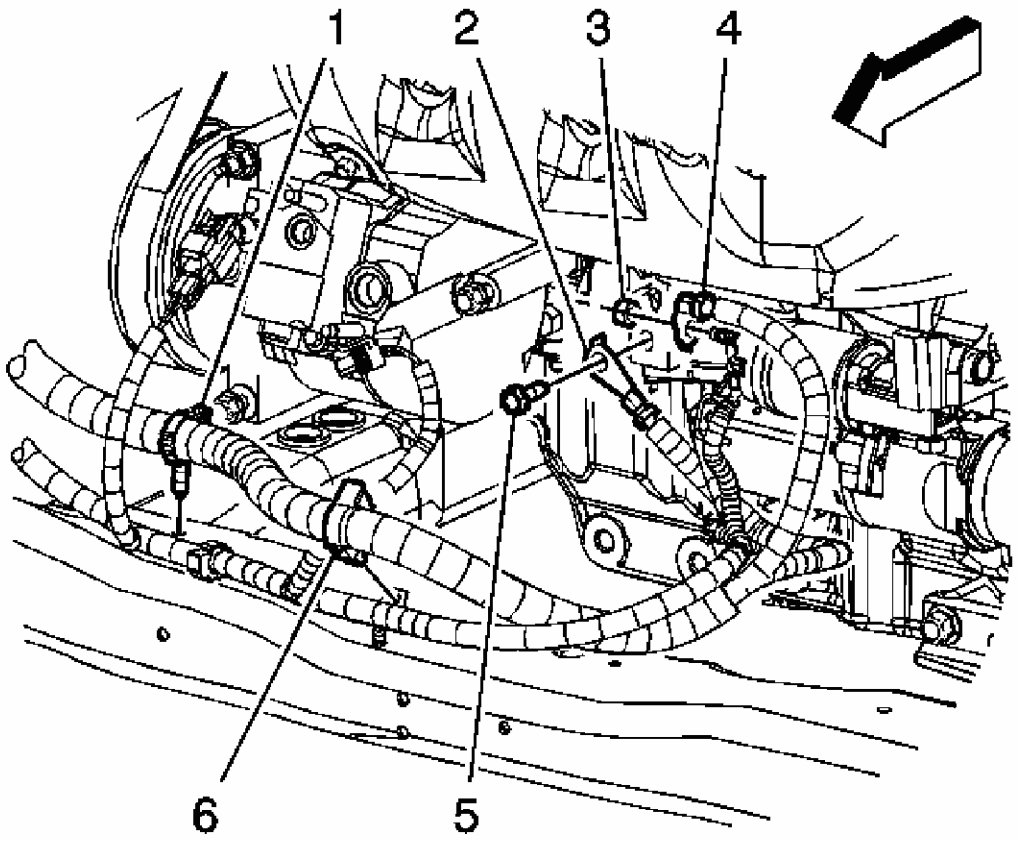


Fig. 39: Identifying Starter Solenoid & Starter Motor Cable Terminals
Courtesy of GENERAL MOTORS CORP.

1. Place the starter cable inside the engine compartment.
2. Install the starter cable retainers (1, 6) to the frame. Ensure that the retainer (6) also secures the engine harness to the frame.

NOTE: **Refer to Fastener Notice .**

3. Position the starter cable ground to the engine and install the starter cable ground bolt (5).

   Tighten: Tighten the bolt to 25 N.m (18 lb ft).

4. Remove the starter solenoid cable terminal (4) to the starter.
5. Install the "BAT" terminal nut (3) to the starter.

Tighten: Tighten the nut to 10 N.m (89 lb in).

6. Install the front compartment sight shield. Refer to **Front Compartment Sight Shields Replacement** .

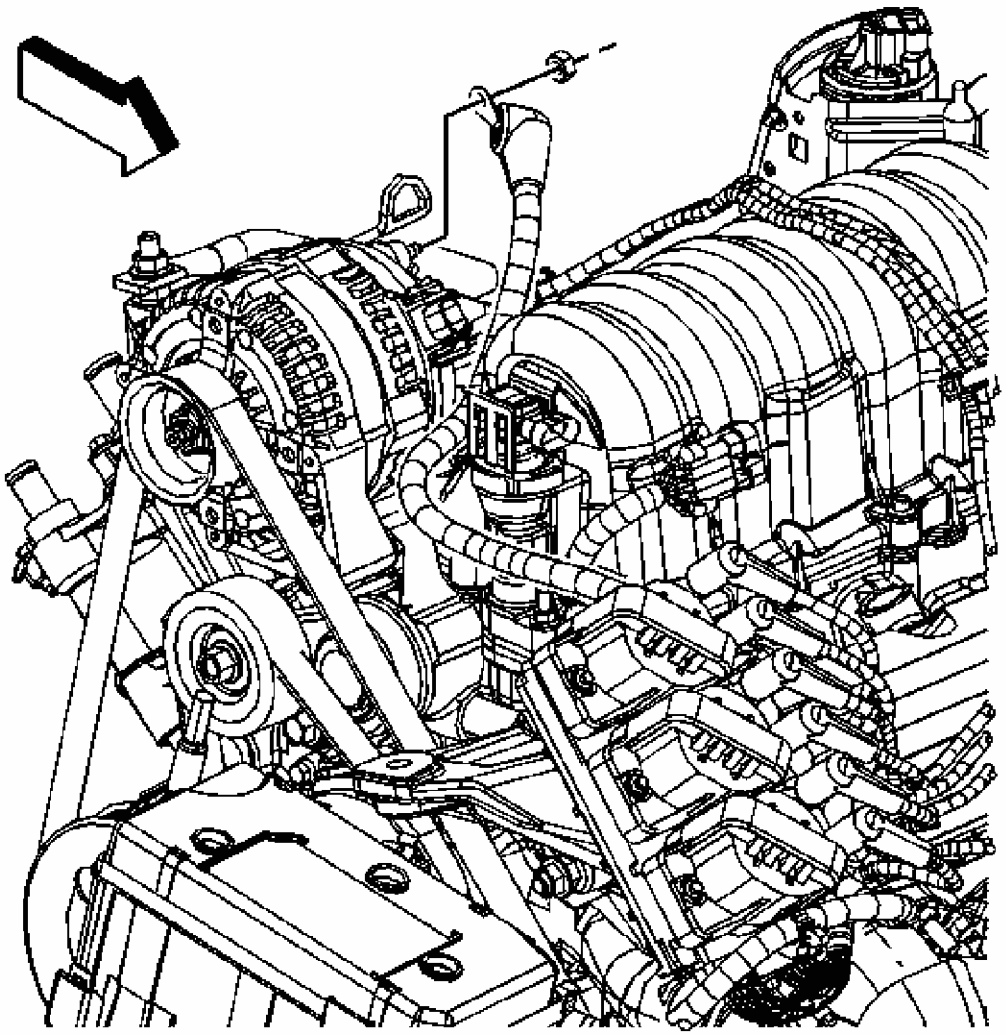


Fig. 40: Removing/Installing Generator Terminal Nut
Courtesy of GENERAL MOTORS CORP.

7. Install the starter cable to the generator.
8. Install the generator terminal nut.

Tighten: Tighten the nut to 20 N.m (15 lb ft).

9. Position the starter cable boot.

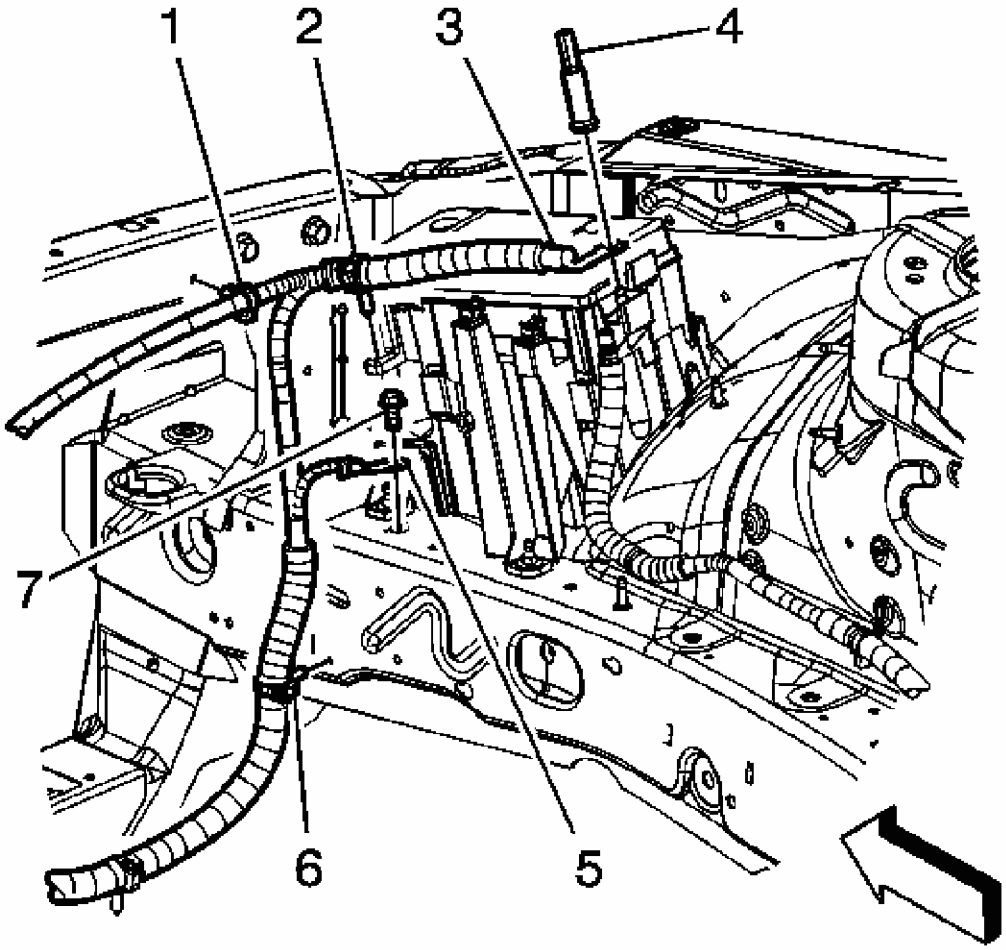


Fig. 41: Identifying Starter Cable & Retaining Nut
Courtesy of GENERAL MOTORS CORP.

10. Install the starter cable retainer (6) to the side rail.
11. Install the starter cable retainer (2) to the BEC housing.
12. Install the starter cable retainer (1) to the tie bar.
13. Position the starter cable terminal (5) to the side rail.
14. Install the starter cable bolt (7) to the side rail.

    Tighten: Tighten the bolt to 20 N.m (15 lb ft).

15. Install the starter cable to the BEC stud.

16. Install the nut (4) securing the starter cable (3) to the BEC.

    Tighten: Tighten the nut to 15 N.m (11 lb ft).

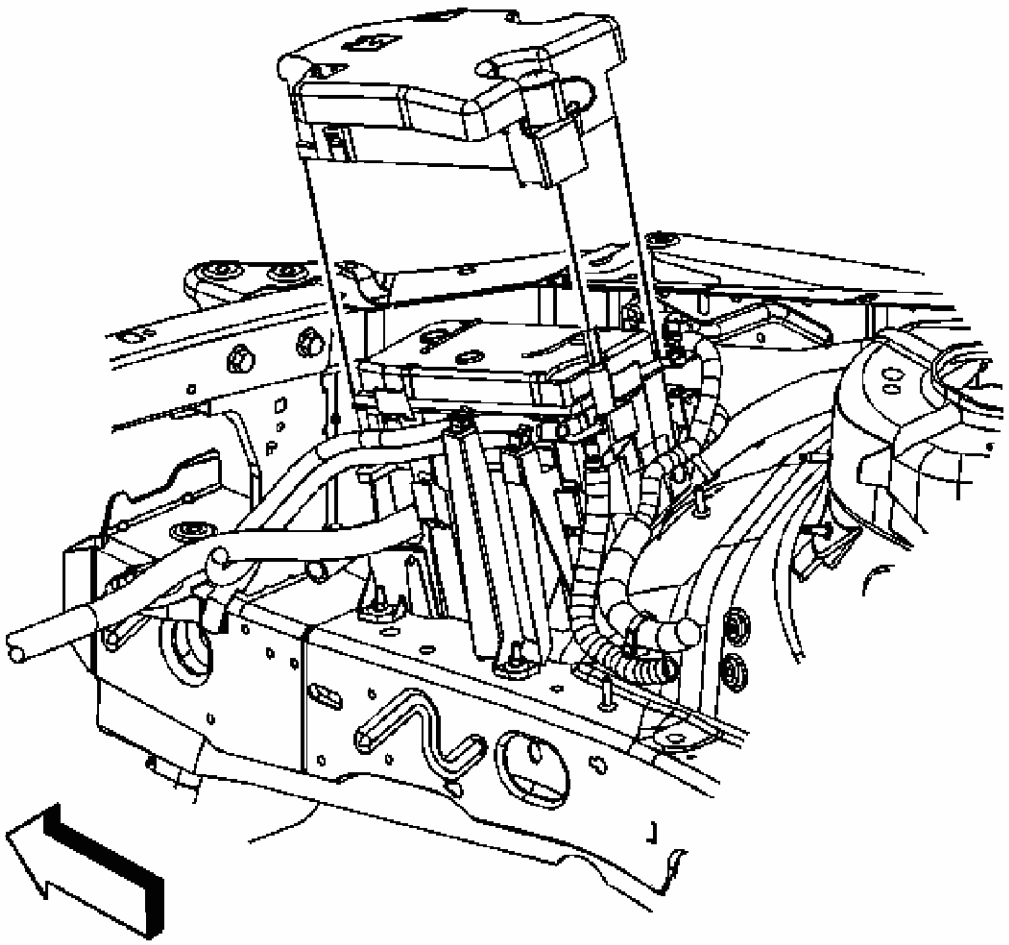


Fig. 42: View Of Junction Block Cover
Courtesy of GENERAL MOTORS CORP.

17. Install the junction block cover.
18. Install the intake manifold cover. Refer to **Intake Manifold Cover Replacement** .
19. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection**.

STARTER SOLENOID CABLE REPLACEMENT (RPO LD8)

Removal Procedure

IMPORTANT:

- **Always use replacement cables that are of the same type, diameter and length of the cables that you are replacing.**
- **Always route the replacement cable the same way as the original cable.**

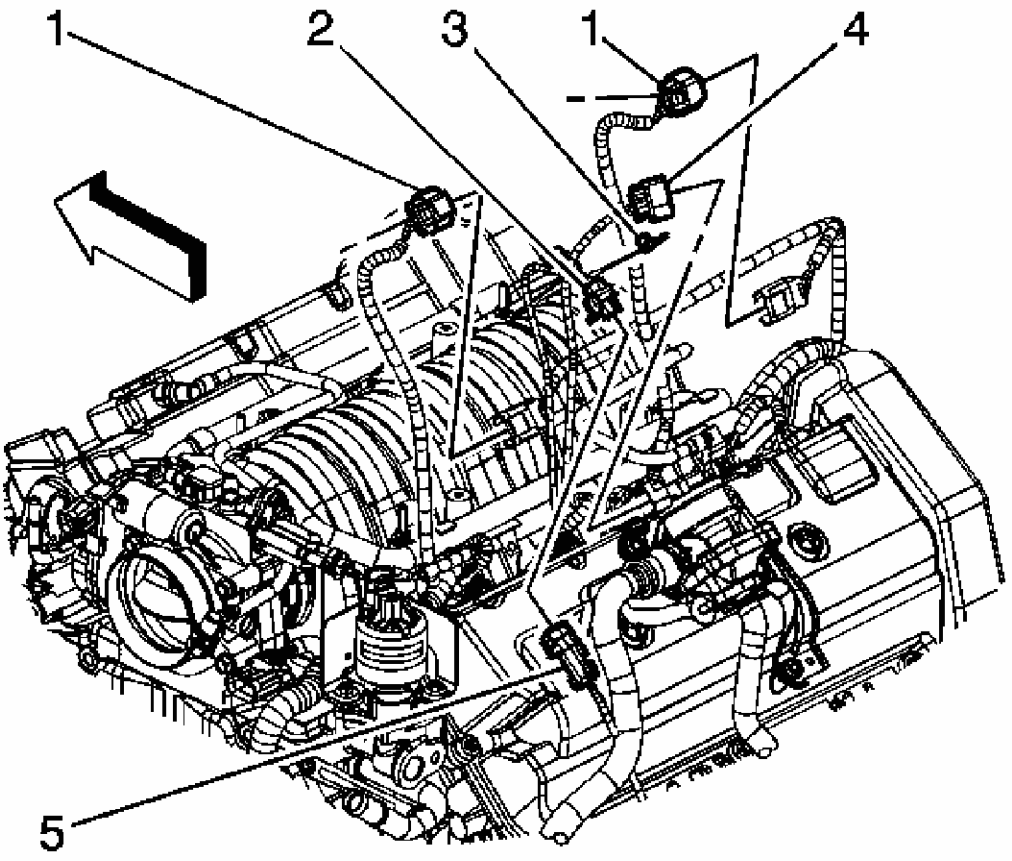


Fig. 43: Identifying Engine Harness Electrical Connector To Starter Solenoid
Courtesy of GENERAL MOTORS CORP.

1. Disconnect the battery negative cable. Refer to **Battery Negative Cable Disconnection and Connection**.
2. Remove the front compartment sight shield. Refer to **Front Compartment Sight Shields Replacement** .
3. Disconnect the engine harness electrical connectors (1) from the starter solenoid cable electrical connectors.

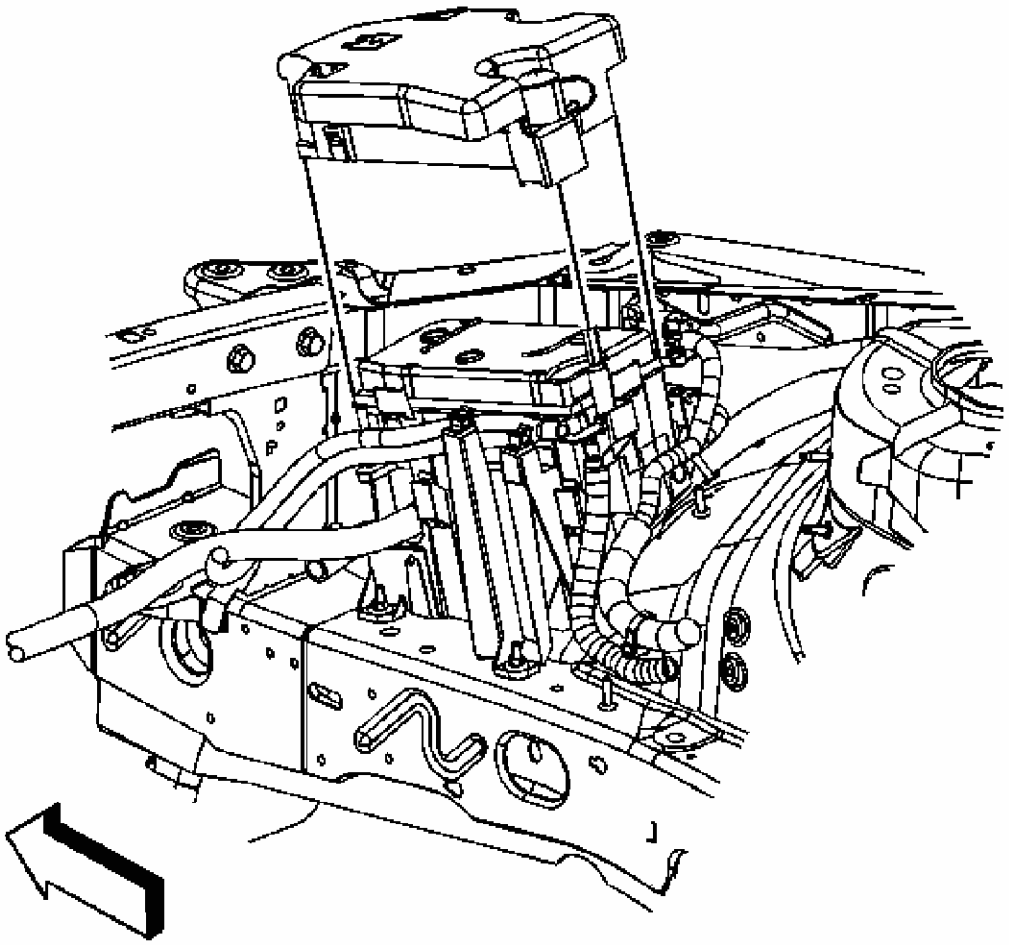


Fig. 44: View Of Junction Block Cover
Courtesy of GENERAL MOTORS CORP.

4. Remove the intake manifold. Refer to **Intake Manifold Replacement** .
5. Disengage the junction block cover lock tabs.
6. Remove the junction block cover.

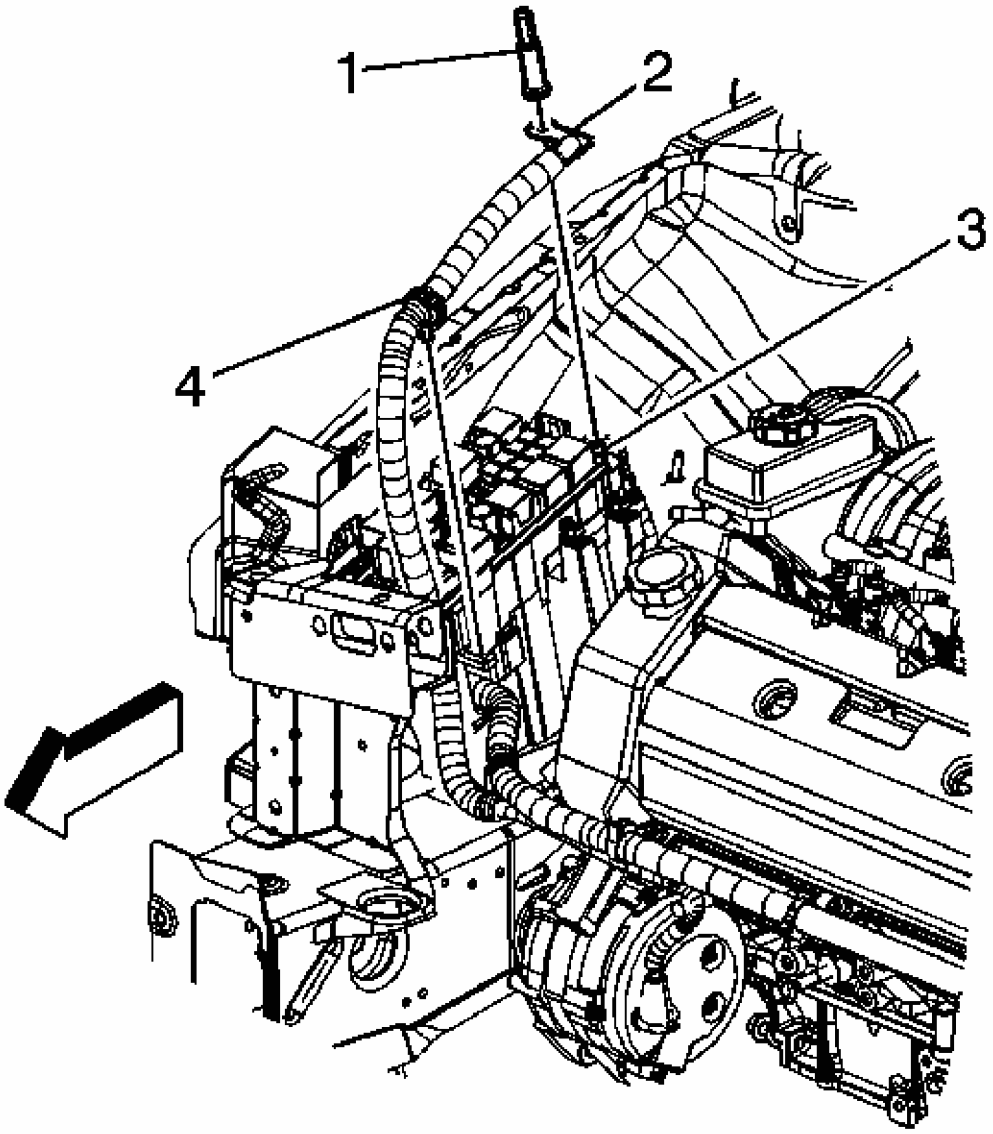


Fig. 45: Identifying Starter Solenoid Cable To Bussed Electrical Center
Courtesy of GENERAL MOTORS CORP.

7. Remove the nut (1) securing the starter solenoid cable to the bussed electrical center (BEC).
8. Remove the starter solenoid cable from the BEC stud.

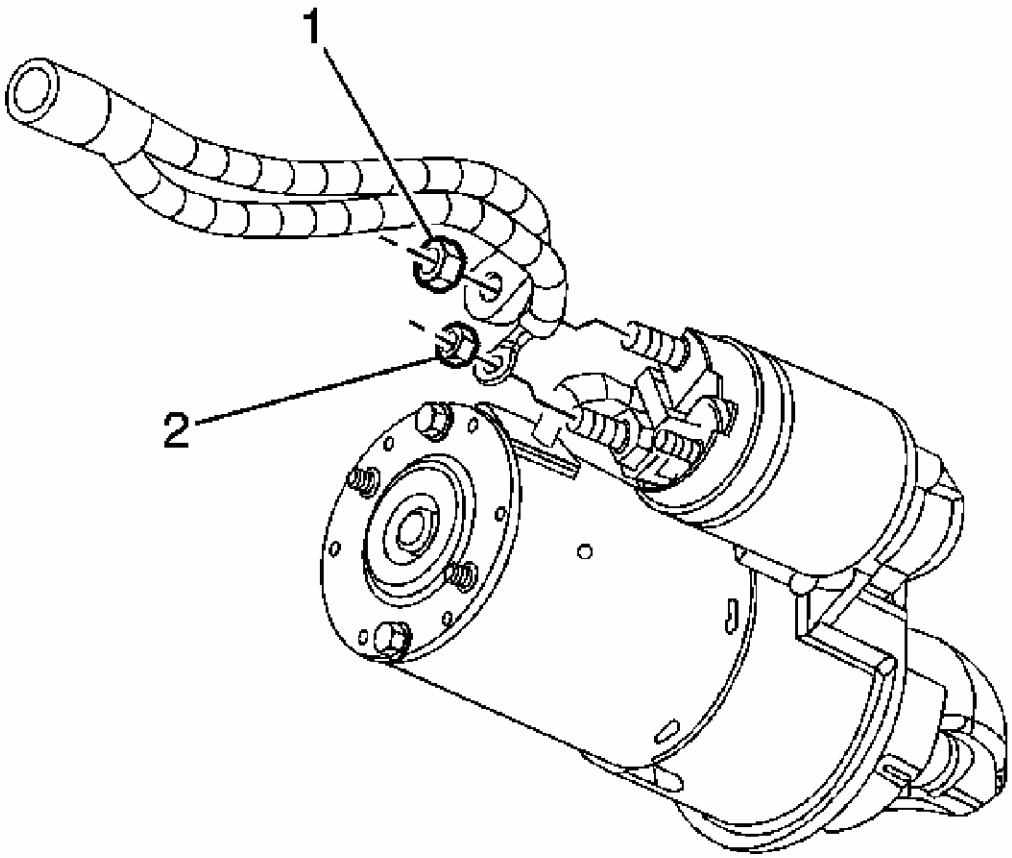


Fig. 46: Identifying "BAT" & "S" Terminals On Starter
Courtesy of GENERAL MOTORS CORP.

9. Remove the "BAT" terminal nut (1) from the starter.
10. Remove the "S" terminal nut (2) from the starter.
11. Remove the starter solenoid cable from the starter.

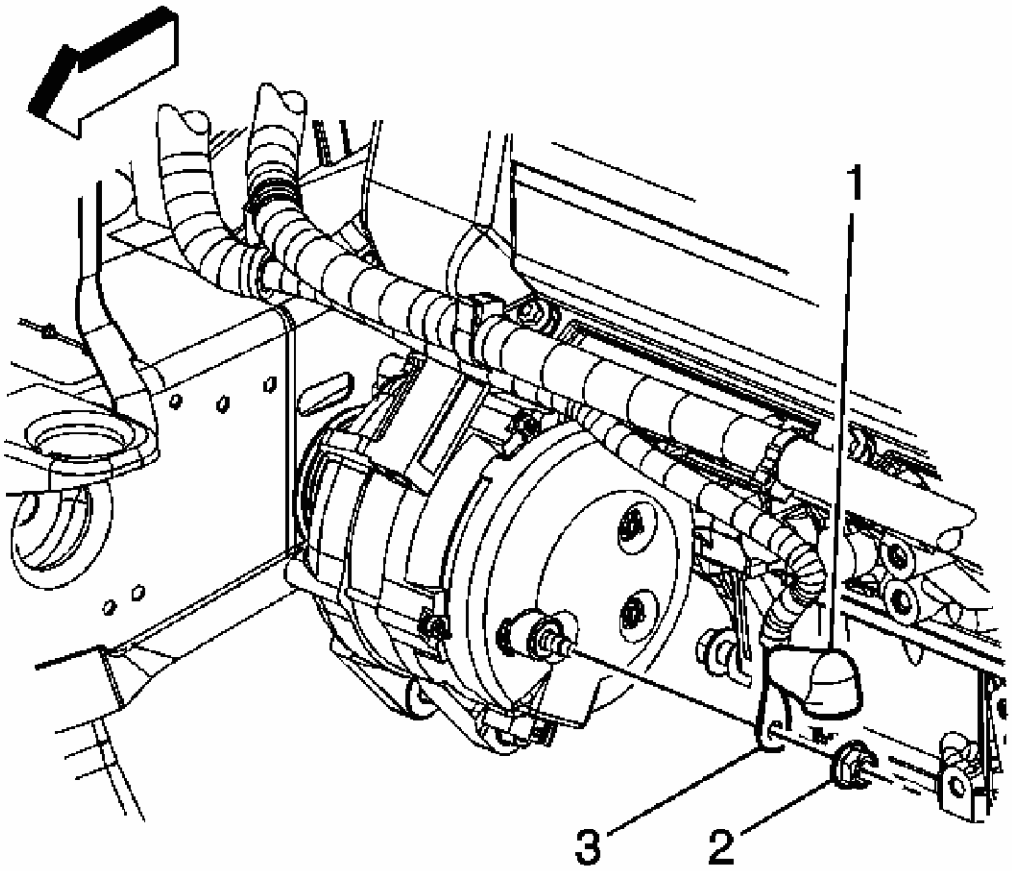


Fig. 47: Identifying Generator Terminal & Starter Solenoid Cable Terminal
Courtesy of GENERAL MOTORS CORP.

12. Reposition the starter solenoid cable protective boot (1) at the generator.
13. Remove the generator terminal nut (2).
14. Remove the starter solenoid cable terminal (3) from the generator.

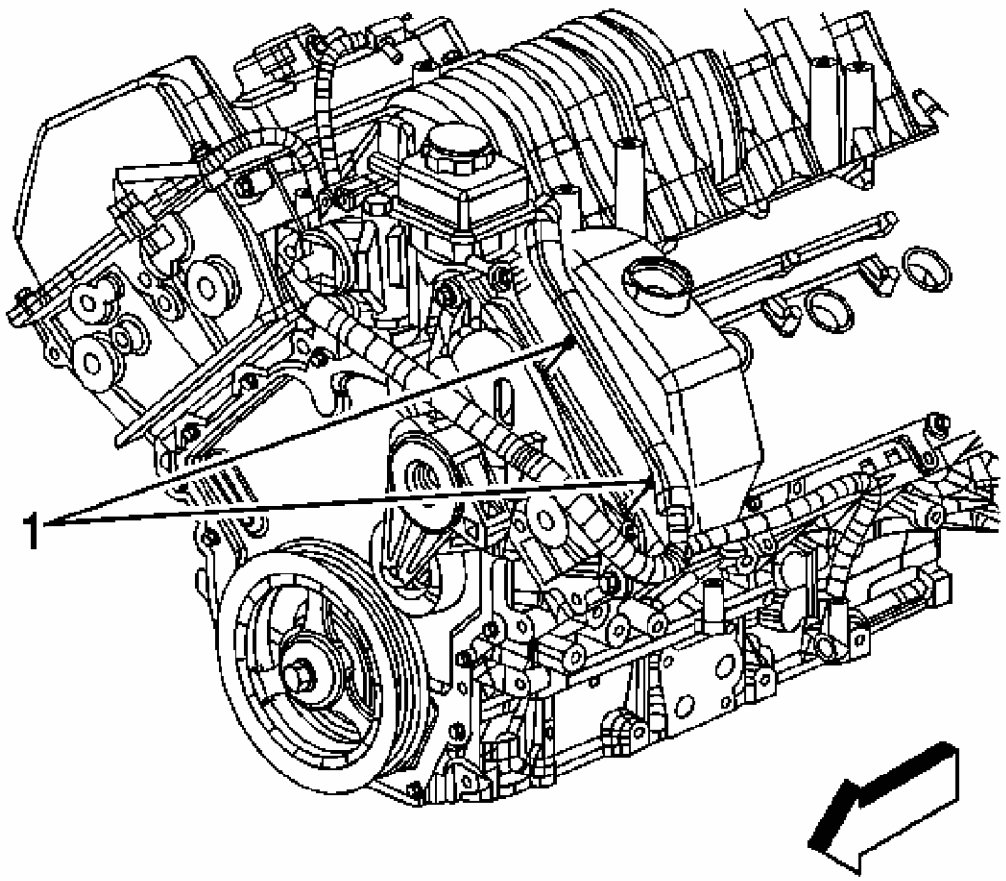


Fig. 48: View Of Starter Solenoid Cable Clips
Courtesy of GENERAL MOTORS CORP.

15. Remove the starter solenoid cable clips (1) from the left camshaft cover.
16. Remove the starter solenoid cable.

Installation Procedure

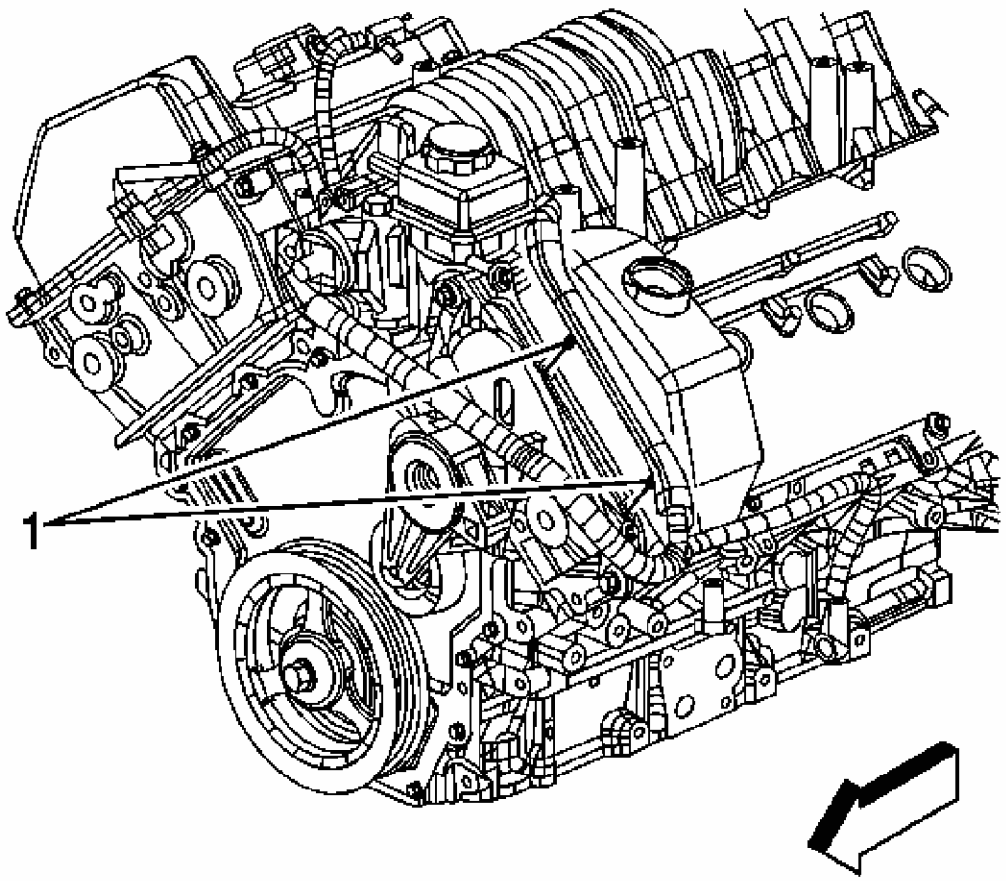


Fig. 49: View Of Starter Solenoid Cable Clips
Courtesy of GENERAL MOTORS CORP.

1. Layout the starter solenoid cable on top of the engine.
2. Install the starter solenoid cable clips (1) to the left camshaft cover.

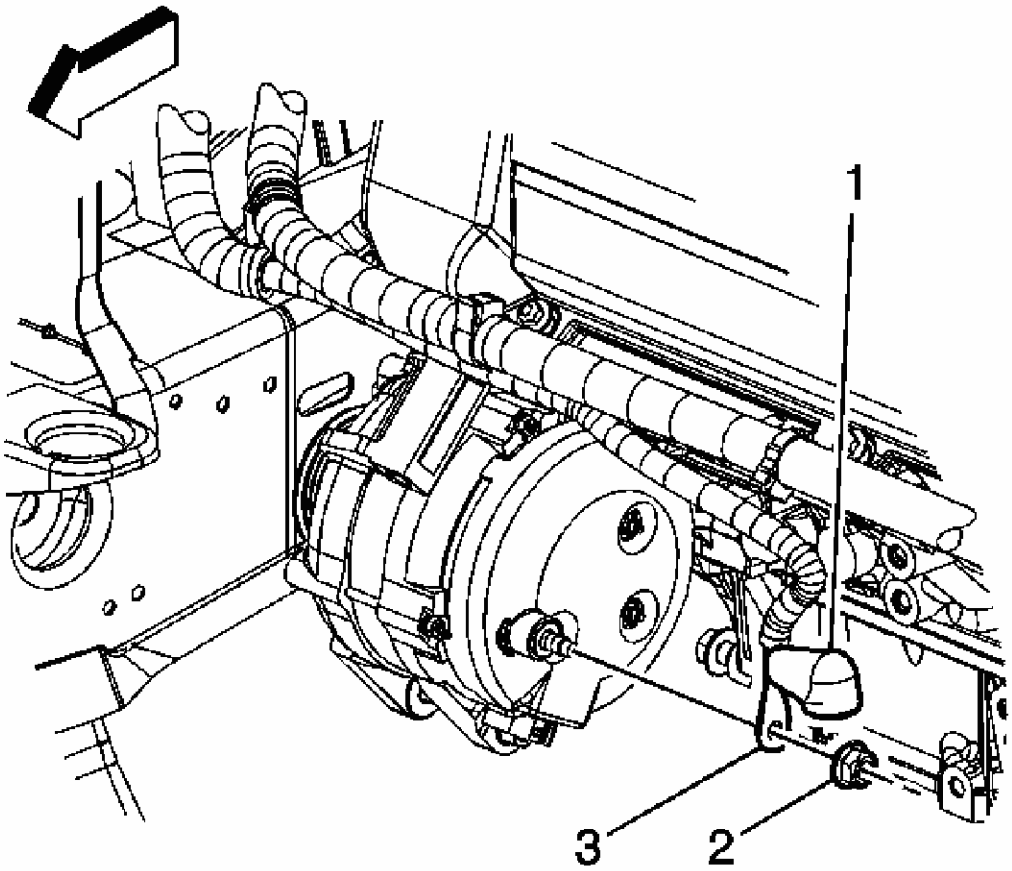


Fig. 50: Identifying Generator Terminal & Starter Solenoid Cable Terminal
Courtesy of GENERAL MOTORS CORP.

3. Install the starter solenoid cable terminal (3) to the generator.

NOTE: **Refer to Fastener Notice .**

4. Install the generator terminal nut (2).

Tighten: Tighten the nut to 12 N.m (106 lb in).

5. Position the starter solenoid cable protective boot (1) at the generator.

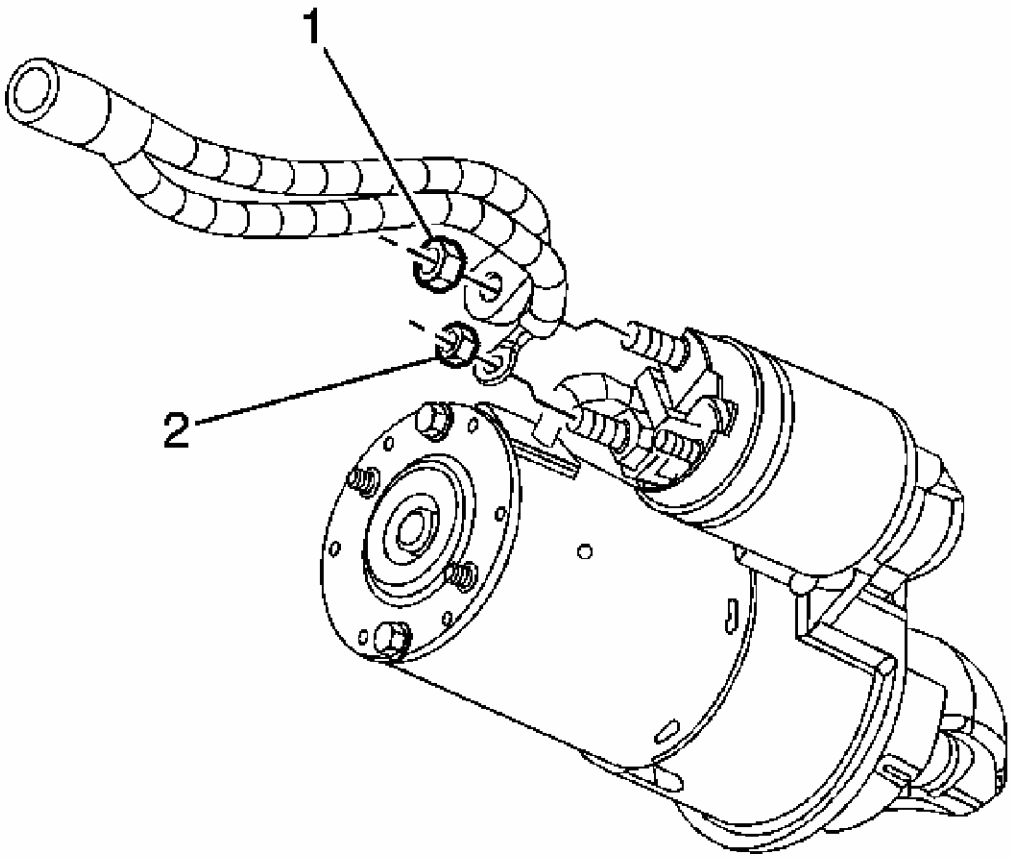


Fig. 51: Identifying "BAT" & "S" Terminals On Starter
Courtesy of GENERAL MOTORS CORP.

6. Install the starter solenoid cable to the starter.
7. Install the "S" terminal nut (2) to the starter.

   Tighten: Tighten the nut to 4 N.m (35 lb in).

8. Install the "BAT" terminal nut (1) to the starter.

   Tighten: Tighten the nut to 10 N.m (89 lb in).

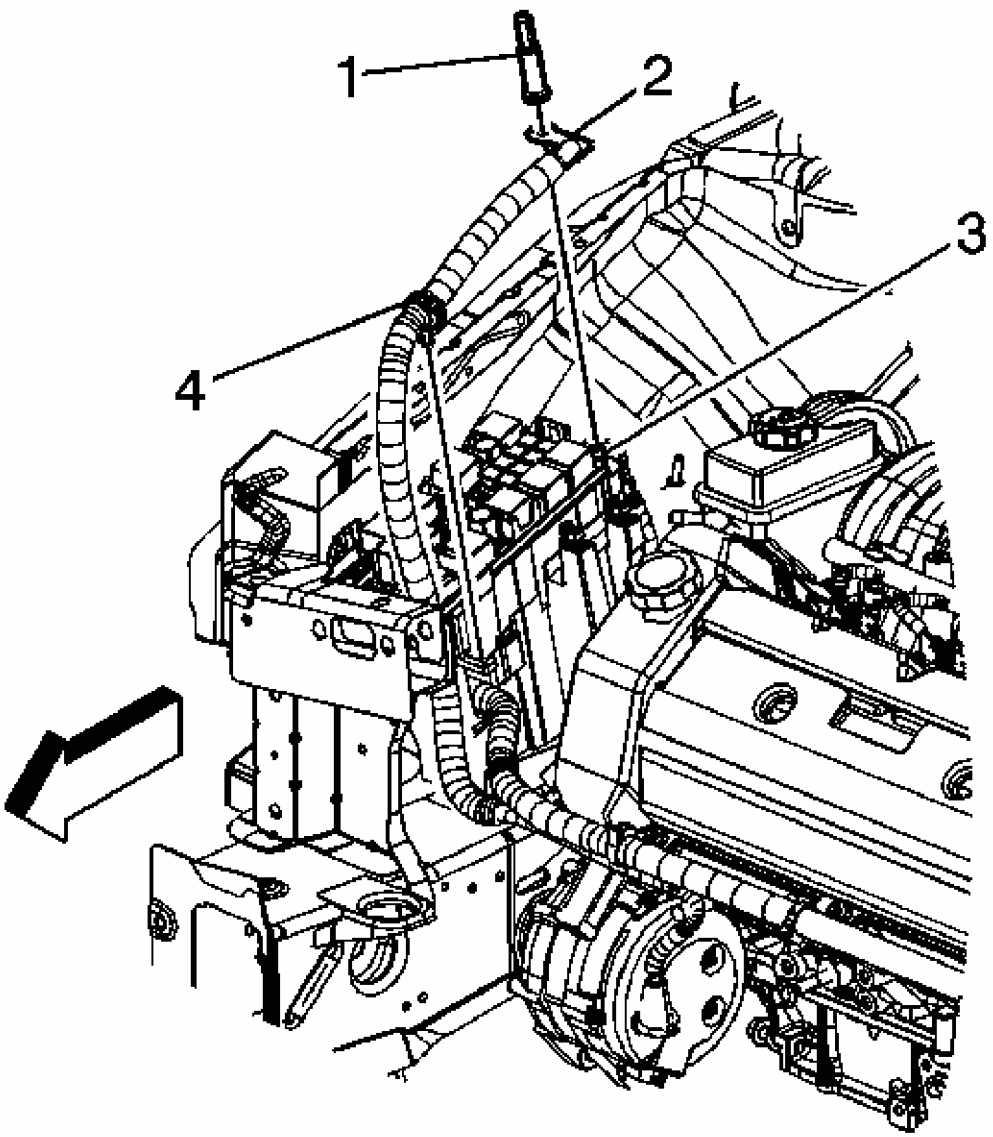


Fig. 52: Identifying Starter Solenoid Cable To Bussed Electrical Center
Courtesy of GENERAL MOTORS CORP.

9. Install the starter solenoid cable to the BEC stud.
10. Install the nut (1) securing the starter solenoid cable to the BEC.

Tighten: Tighten the nut to 15 N.m (11 lb ft).

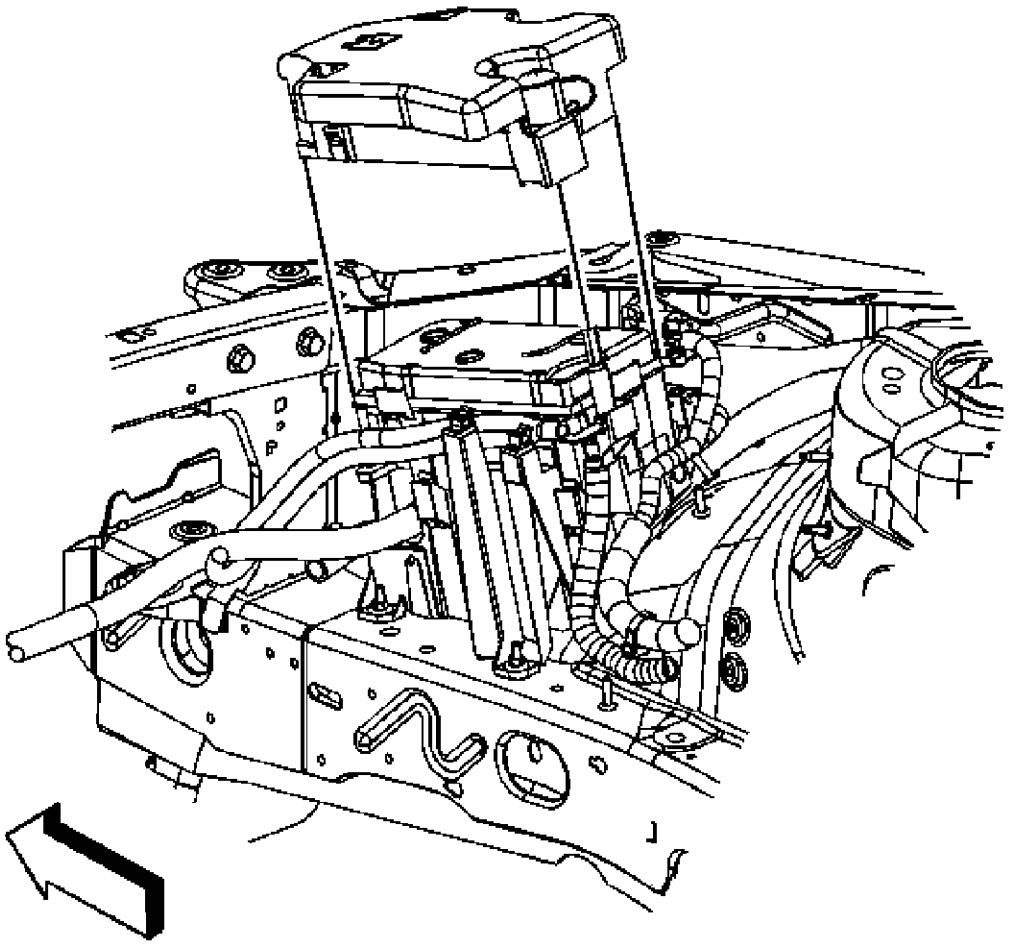


Fig. 53: View Of Junction Block Cover
Courtesy of GENERAL MOTORS CORP.

11. Install the junction block cover.
12. Install the intake manifold. Refer to **Intake Manifold Replacement** .

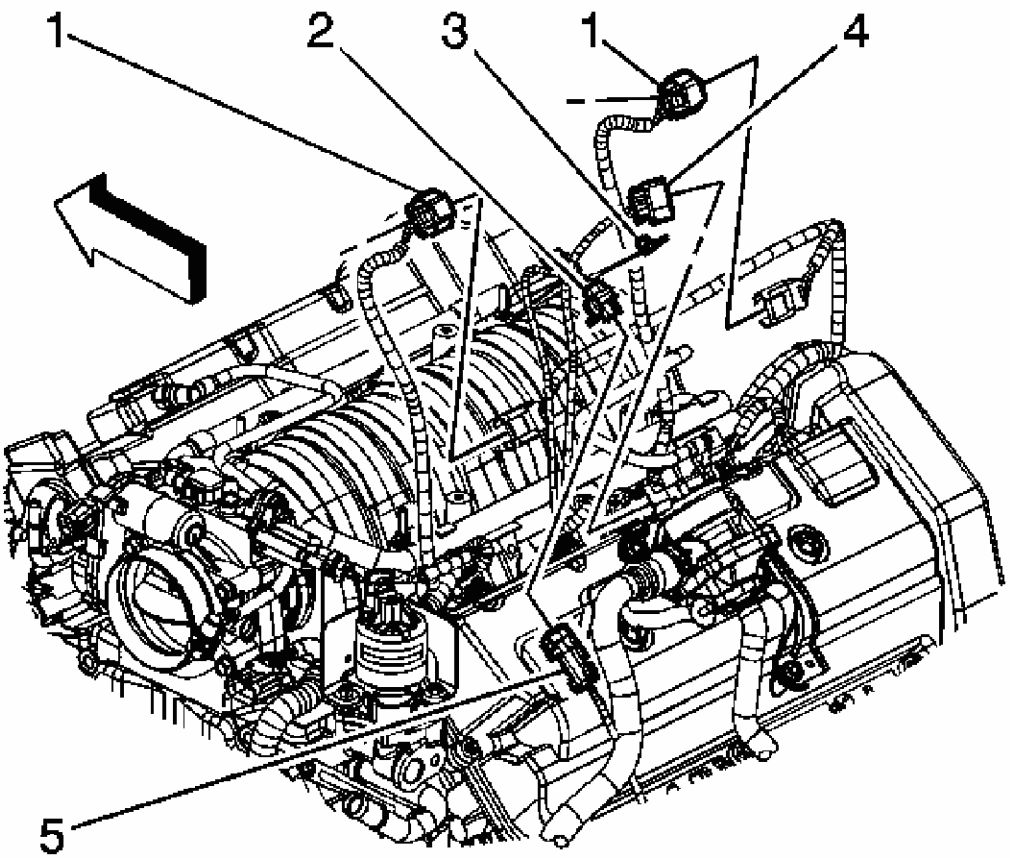


Fig. 54: Identifying Engine Harness Electrical Connector To Starter Solenoid
Courtesy of GENERAL MOTORS CORP.

13. Connect the engine harness electrical connectors (1) to the starter solenoid cable electrical connectors.
14. Install the front compartment sight shield. Refer to **Front Compartment Sight Shields Replacement** .
15. Connect the battery negative cable. Refer to **Battery Negative Cable Disconnection and Connection**.

BATTERY REPLACEMENT

Removal Procedure

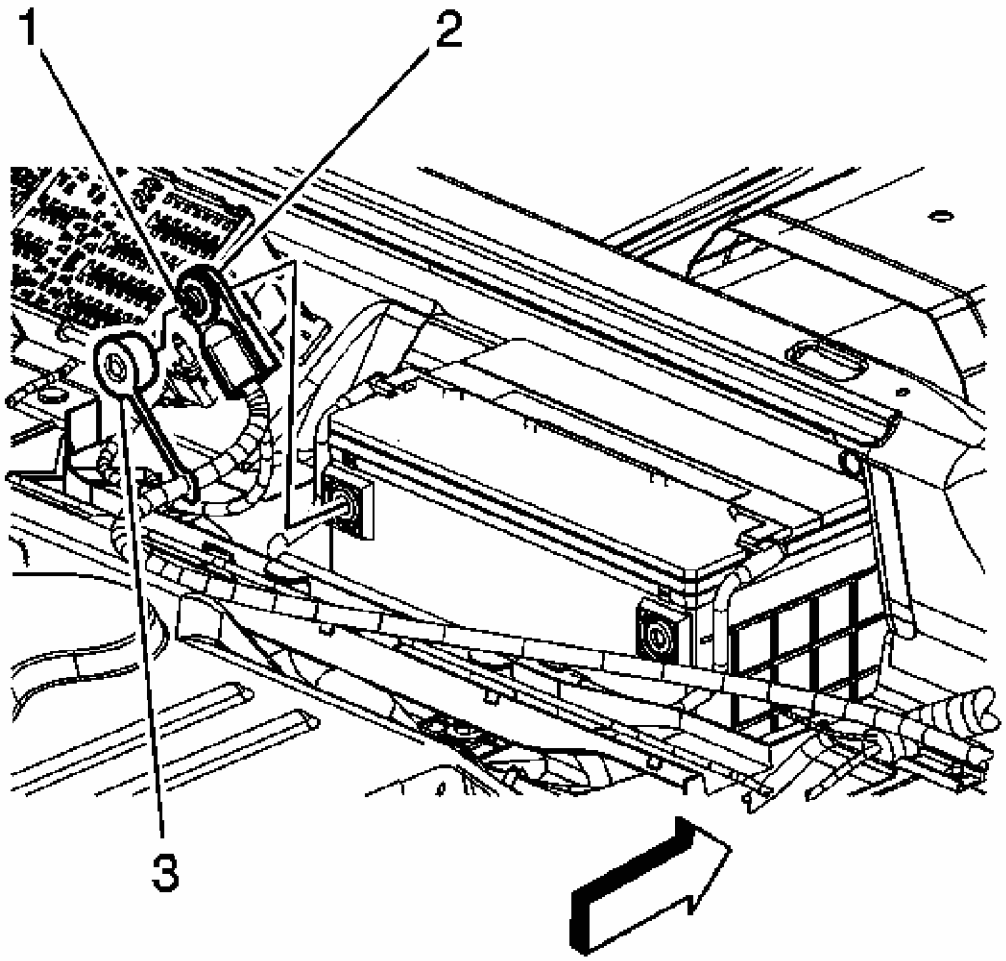


Fig. 55: Removing/Installing Positive Battery Cable Cover
Courtesy of GENERAL MOTORS CORP.

1. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection**.
2. Unsnap the positive battery cable cover (3) and reposition.
3. Loosen the positive battery cable bolt (1).
4. Separate the positive battery cable (2) from the battery.

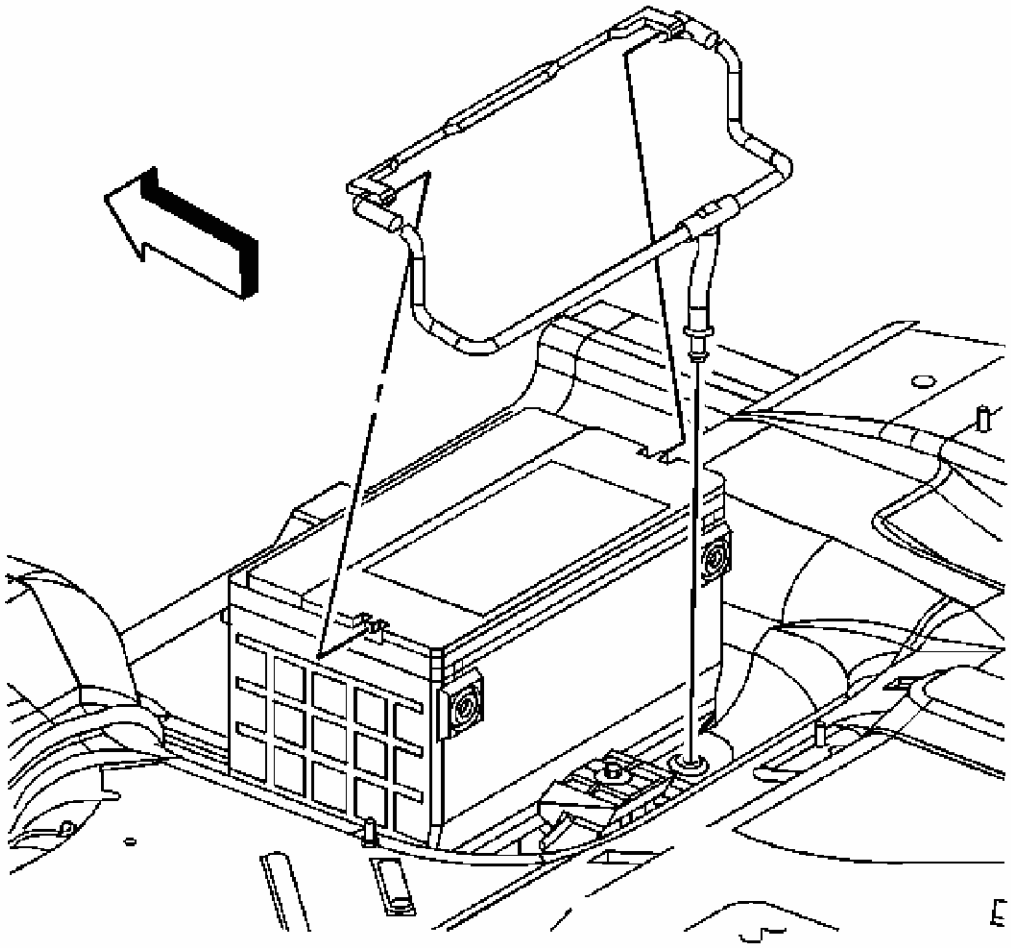


Fig. 56: Removing/Installing Battery Vent Tube
Courtesy of GENERAL MOTORS CORP.

5. Remove the battery vent tube from the battery.

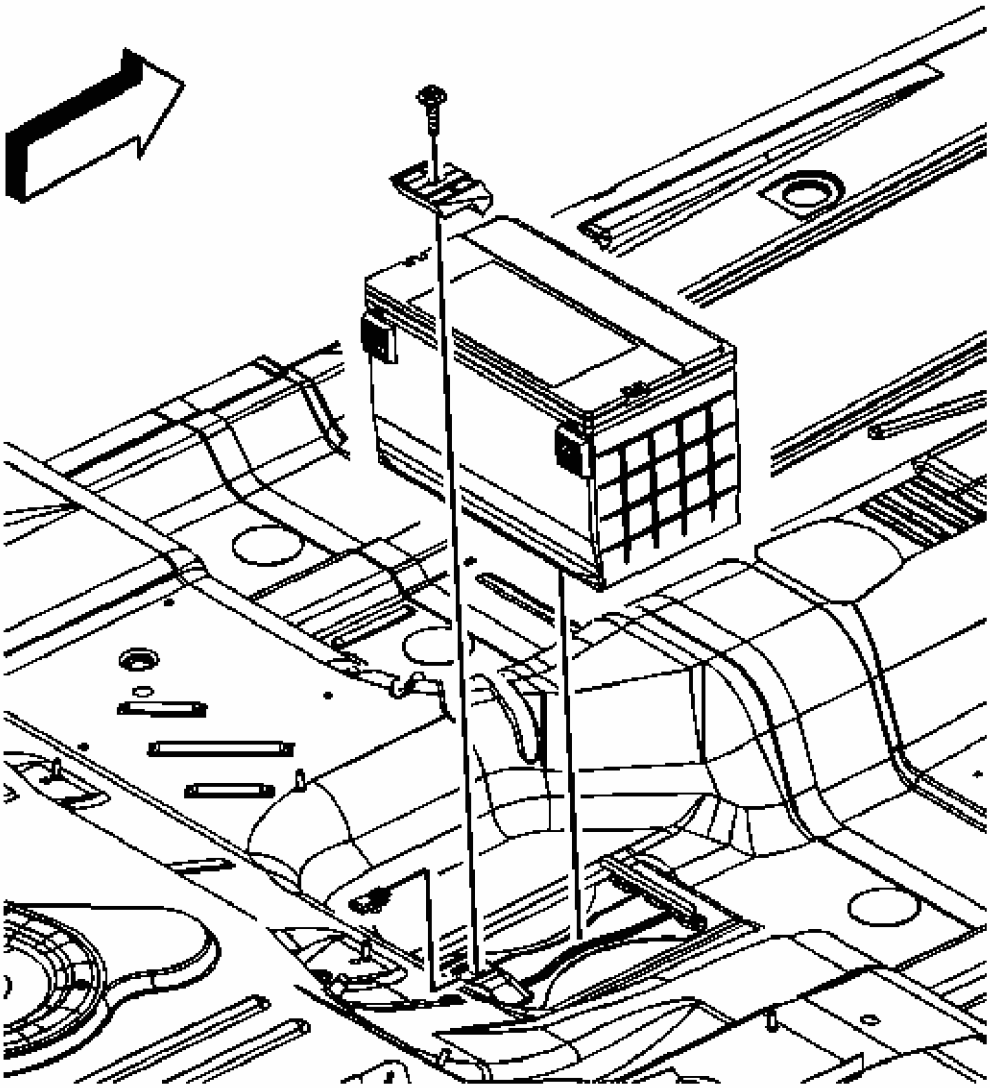


Fig. 57: Removing/Installing Battery Hold Down
Courtesy of GENERAL MOTORS CORP.

6. Remove the battery hold down bolt and hold down.
7. Remove the battery.

Installation Procedure

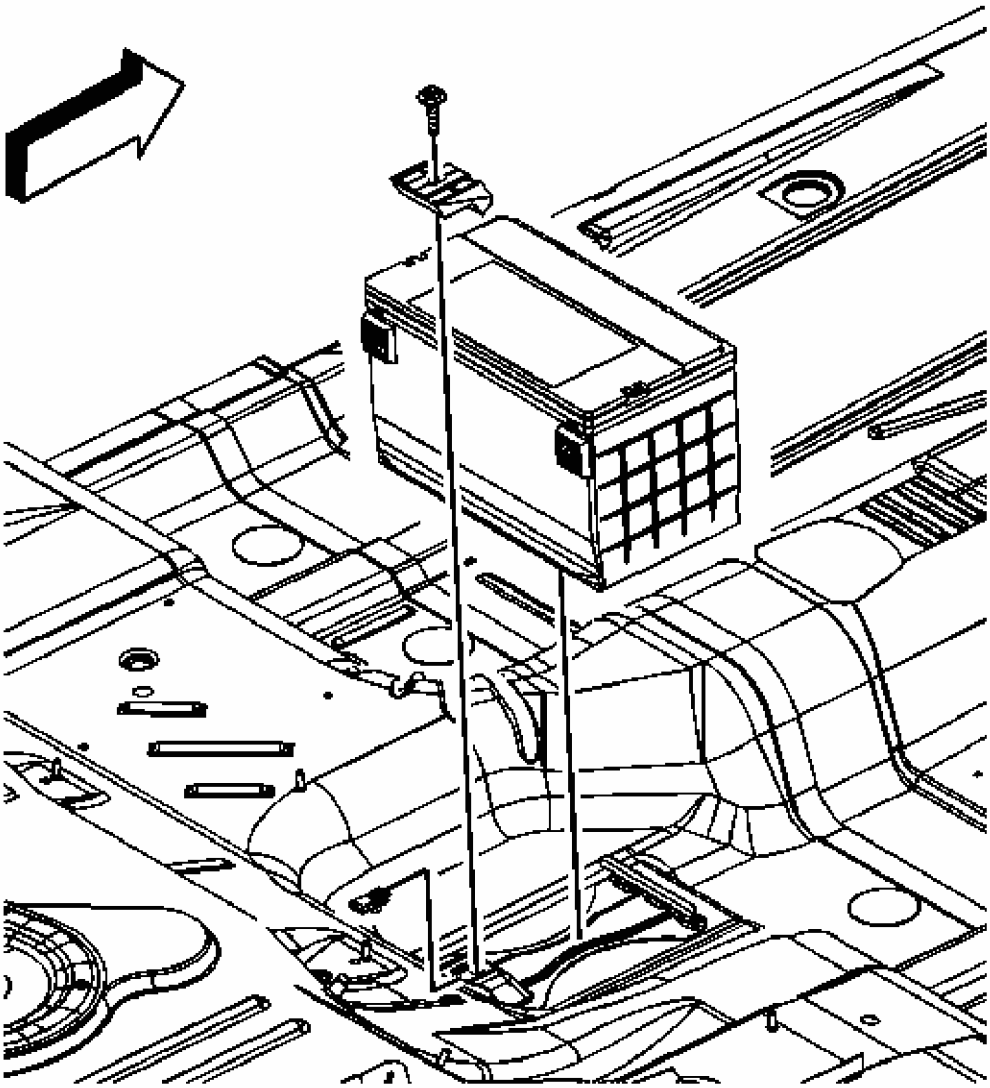


Fig. 58: Removing/Installing Battery Hold Down
Courtesy of GENERAL MOTORS CORP.

1. Install the battery.

   NOTE: **Refer to Fastener Notice .**

2. Install the battery hold down and bolt.

   Tighten: Tighten the bolt to 17 N.m (13 lb ft).

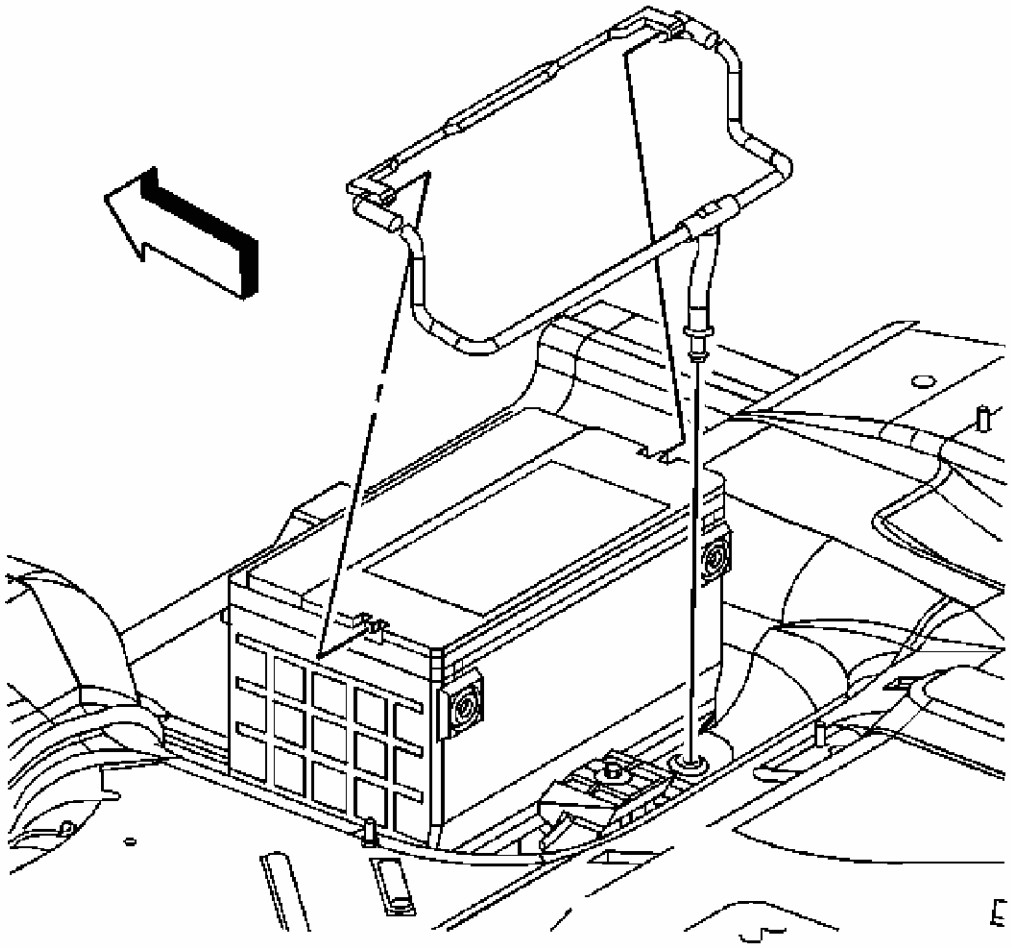


Fig. 59: Removing/Installing Battery Vent Tube
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Ensure that the vent tube is properly routed through the floor pan grommet.

3. Install the battery vent tube to the battery.

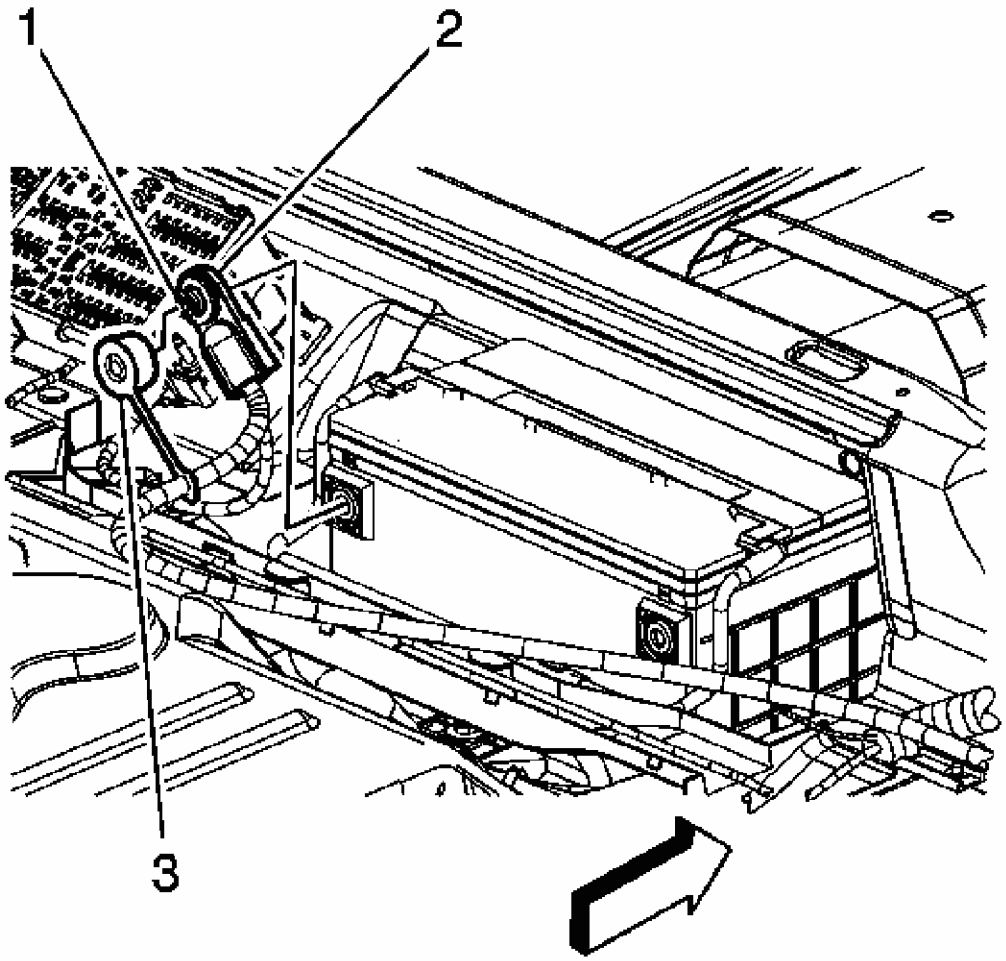


Fig. 60: Removing/Installing Positive Battery Cable Cover
Courtesy of GENERAL MOTORS CORP.

4. Position the positive battery cable (2) to the battery.
5. Tighten the positive battery cable bolt (1).

   Tighten: Tighten the bolt to 17 N.m (13 lb ft).

6. Snap the positive battery cable cover (3) closed.
7. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection**.

ENGINE GROUND CABLE REPLACEMENT (RPO LD8)

Removal Procedure

IMPORTANT:

- **Always use replacement cables that are of the same type, diameter and length of the cables that you are replacing.**
- **Always route the replacement cable the same way as the original cable.**

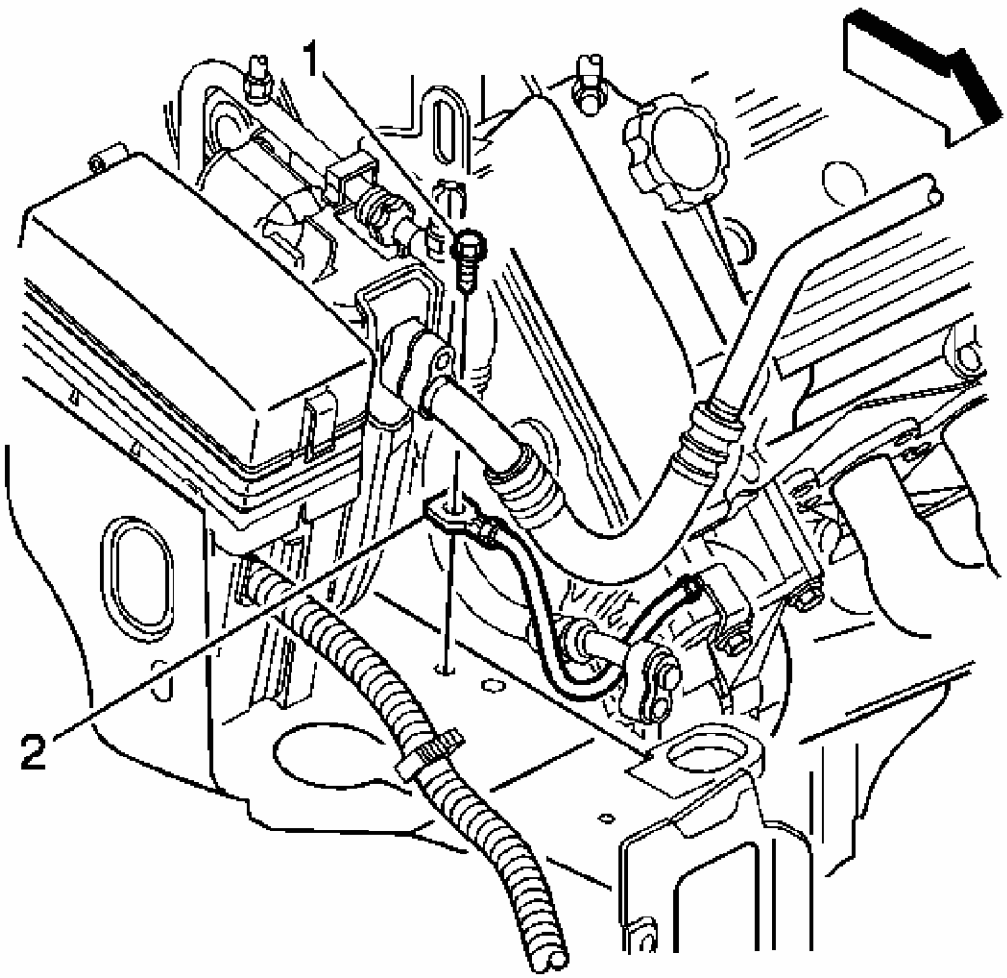


Fig. 61: Identifying Engine Ground Cable
Courtesy of GENERAL MOTORS CORP.

1. Remove the front compartment sight shield. Refer to **Front Compartment Sight Shields Replacement** .
2. Remove the bolt (1) securing the engine ground cable (2) to the right side body frame

rail.

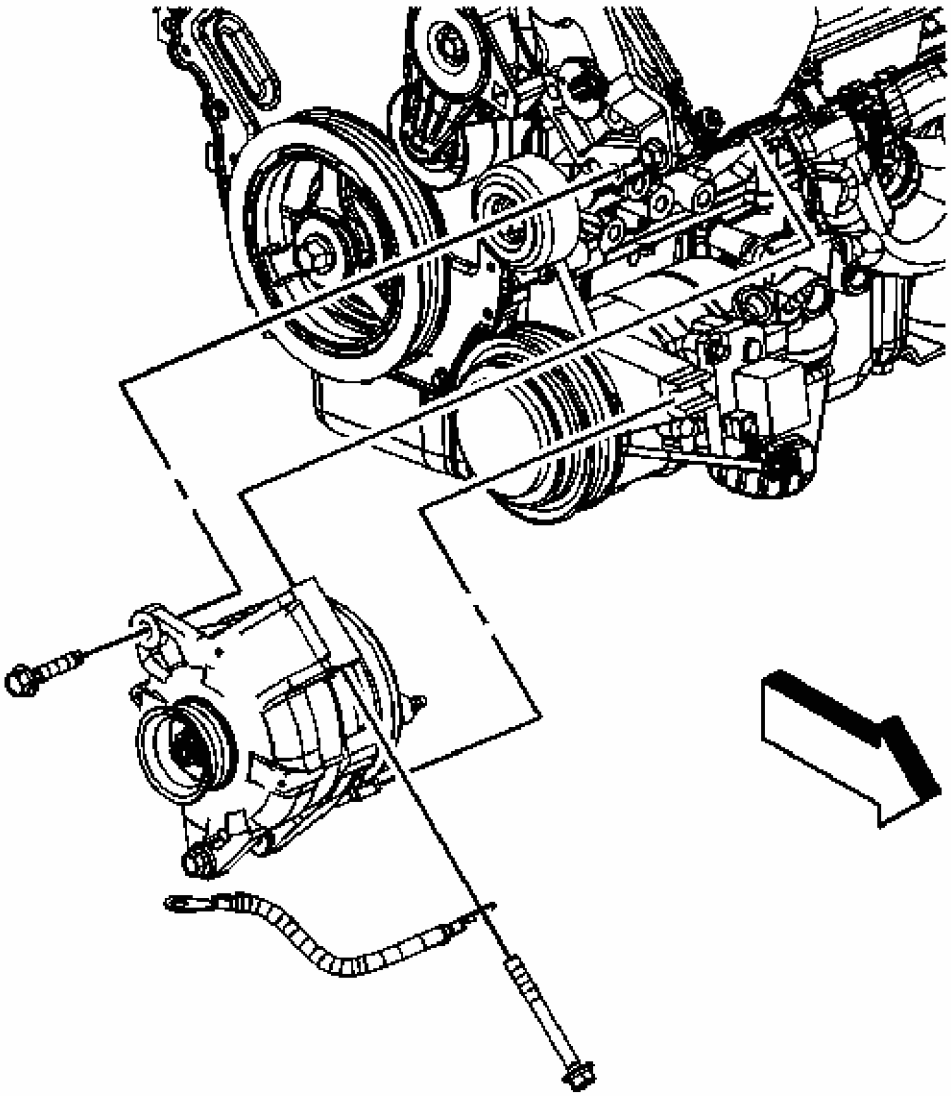


Fig. 62: Identifying Rear Generator Bolt & Ground Cable
Courtesy of GENERAL MOTORS CORP.

3. Remove the rear generator bolt.
4. Remove the engine ground cable.

Installation Procedure

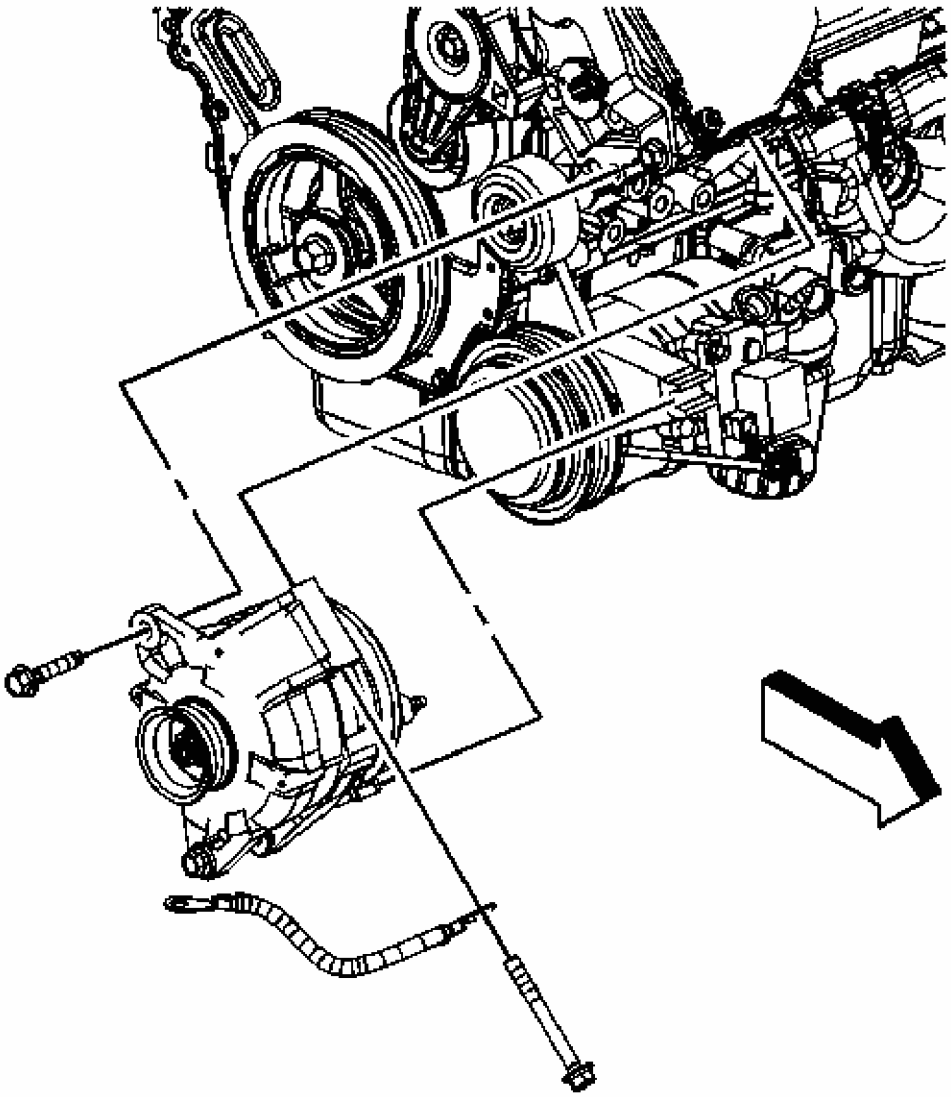


Fig. 63: Identifying Rear Generator Bolt & Ground Cable
Courtesy of GENERAL MOTORS CORP.

1. Position the engine ground cable to the generator.

NOTE: **Refer to Fastener Notice .**

2. Install the rear generator bolt.

Tighten: Tighten the bolt to 50 N.m (37 lb ft).

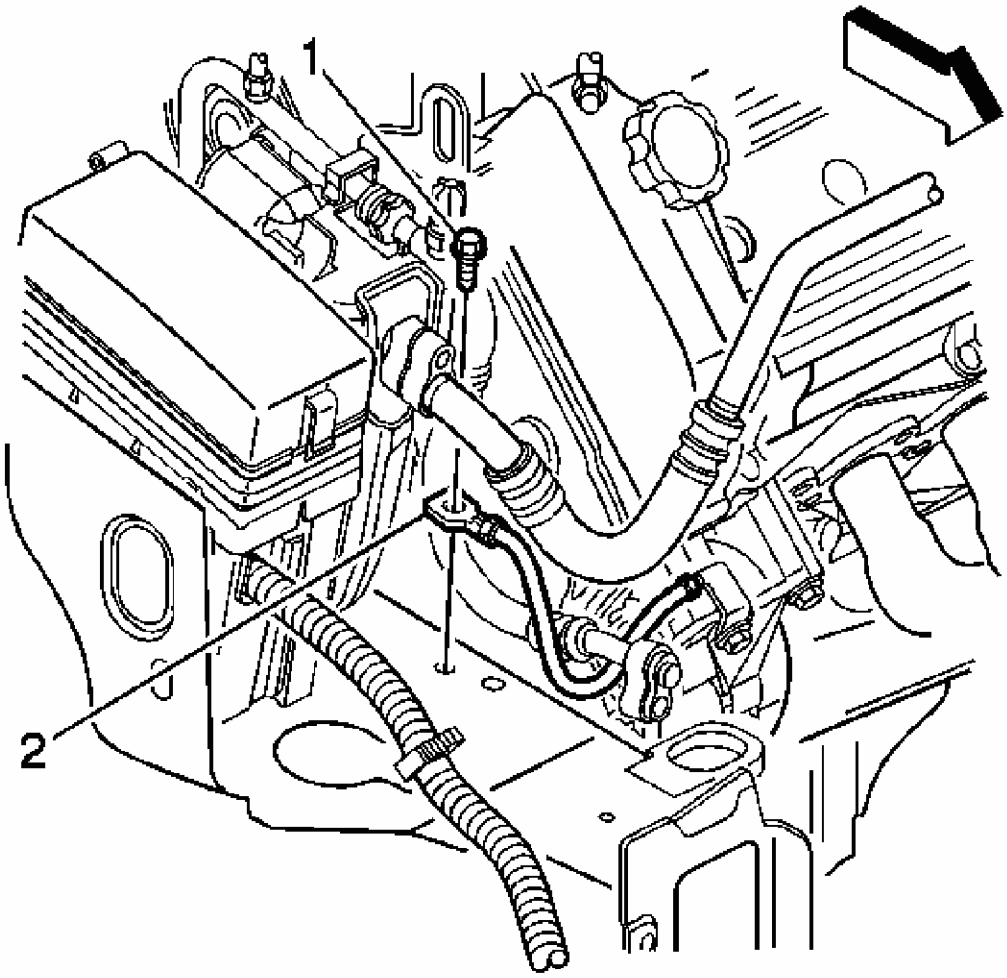


Fig. 64: Identifying Engine Ground Cable
Courtesy of GENERAL MOTORS CORP.

3. Install the bolt (1) securing the engine ground cable (2) to the right side body frame rail.

   Tighten: Tighten the bolt to 25 N.m (18 lb ft).

4. Install the front compartment sight shield. Refer to **Front Compartment Sight Shields Replacement** .

ENGINE GROUND STRAP REPLACEMENT (RPO LD8)

Removal Procedure

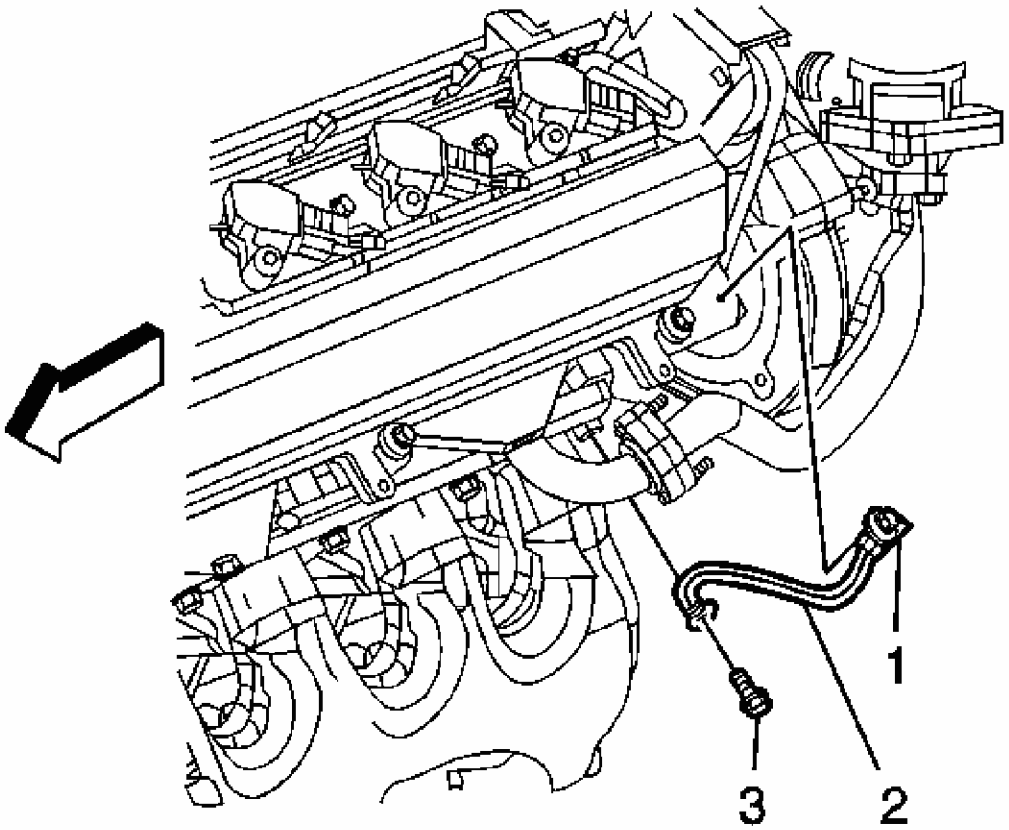


Fig. 65: Identifying ICM Ground Strap
Courtesy of GENERAL MOTORS CORP.

1. Remove the fuel injector sight shield, if necessary. Refer to **Fuel Injector Sight Shield Replacement** .
2. Remove the ignition control module (ICM) ground strap bolt (3) from the cylinder head.
3. Loosen the ICM ground strap bolt (1) from the camshaft cover.
4. Remove the ICM ground strap (2).

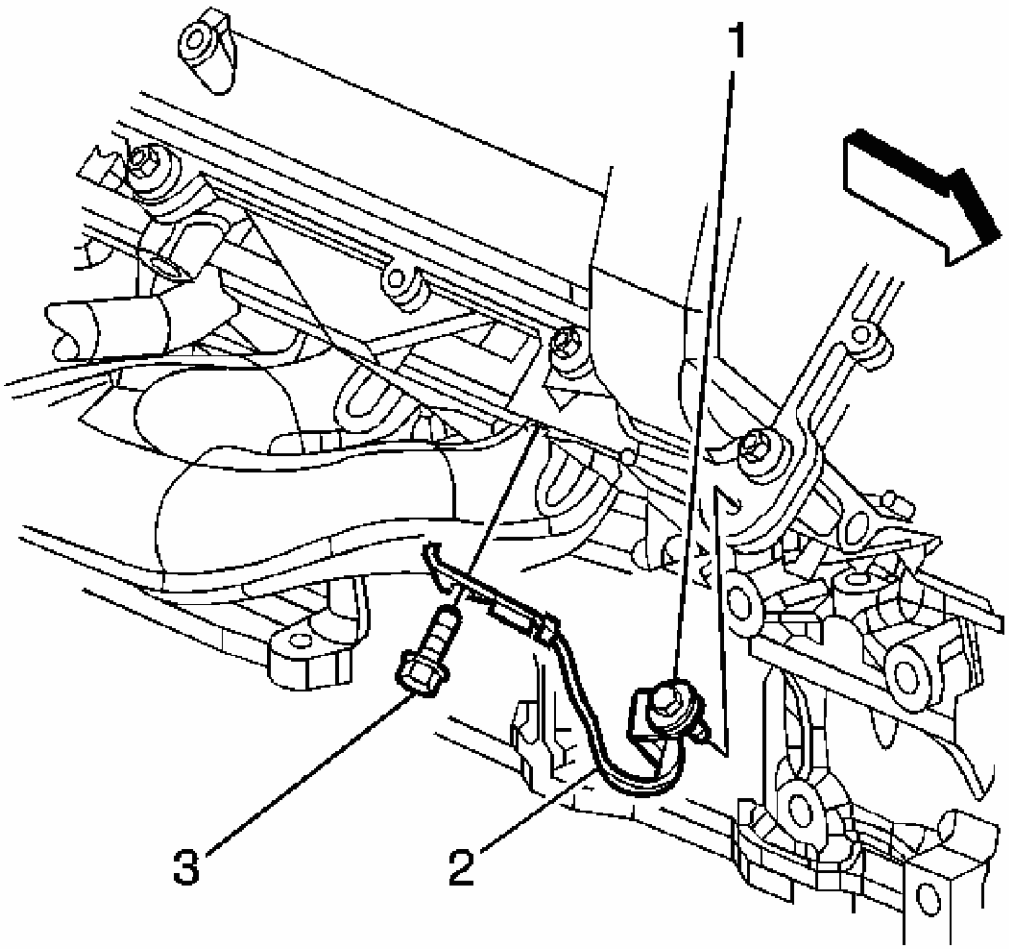


Fig. 66: Removing/Installing ICM Ground Strap
Courtesy of GENERAL MOTORS CORP.

5. Remove the ICM ground strap bolt (3) from the cylinder head.
6. Loosen the ICM ground strap bolt (1) from the camshaft cover.
7. Remove the ICM ground strap (2).

Installation Procedure

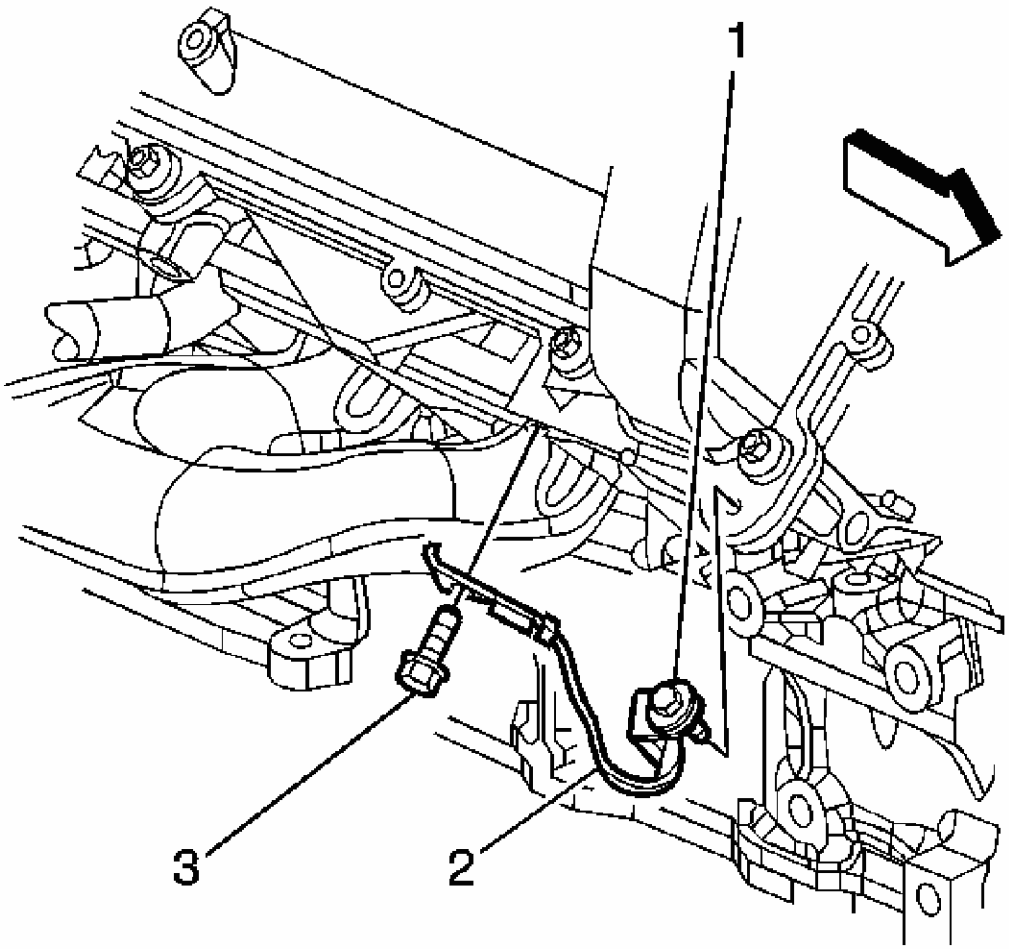


Fig. 67: Removing/Installing ICM Ground Strap
Courtesy of GENERAL MOTORS CORP.

1. Install the ICM ground strap (2).

NOTE: **Refer to Fastener Notice .**

2. Tighten the ICM ground strap bolt (1) to the camshaft cover.

Tighten: Tighten the bolt to 10 N.m (89 lb in).

3. Install the ICM ground strap bolt (3) to the cylinder head.

Tighten: Tighten the bolt to 25 N.m (18 lb ft).

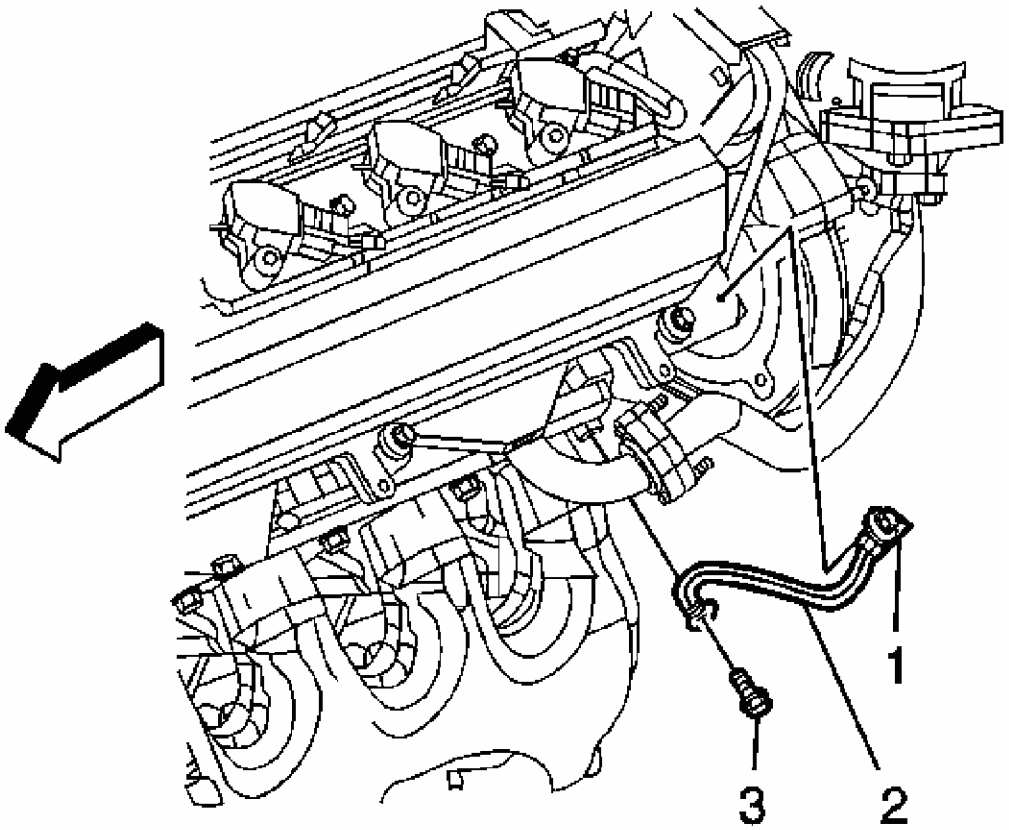


Fig. 68: Identifying ICM Ground Strap
Courtesy of GENERAL MOTORS CORP.

4. Install the ICM ground strap (2).
5. Tighten the ICM ground strap bolt (1) to the camshaft cover.

   Tighten: Tighten the bolt to 10 N.m (89 lb in).

6. Install the ICM ground strap bolt (3) to the cylinder head.

   Tighten: Tighten the bolt to 10 N.m (89 lb in).

7. Install the fuel injector sight shield, if necessary. Refer to **Fuel Injector Sight Shield Replacement** .

STARTER MOTOR REPLACEMENT (RPO L26)

Removal Procedure

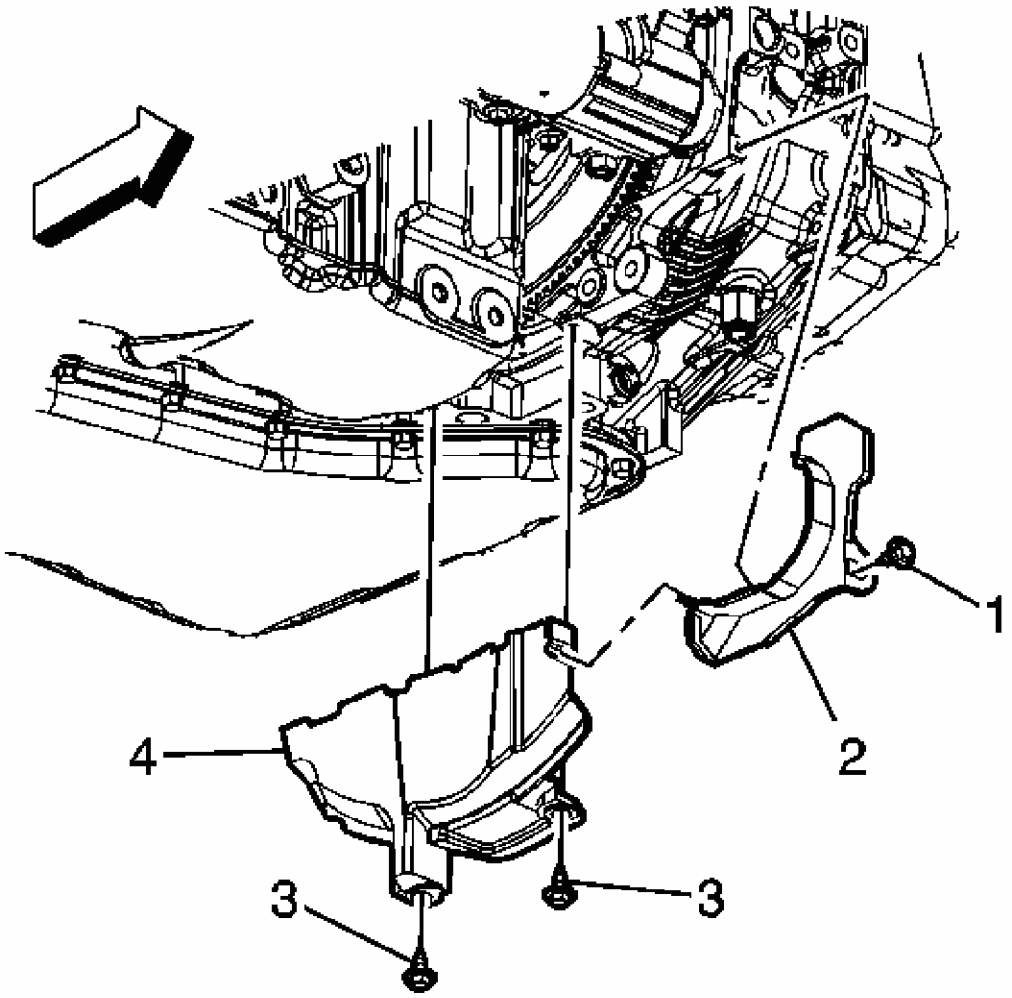


Fig. 69: Identifying Transaxle Converter Cover
Courtesy of GENERAL MOTORS CORP.

1. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection**.
2. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
3. Remove the transmission brace. Refer to **Automatic Transmission Brace Replacement (Converter Housing)** or **Automatic Transmission Brace Replacement (Extension Housing)** .
4. Remove the transaxle converter cover bolt (1).
5. Remove the transaxle converter cover (2).

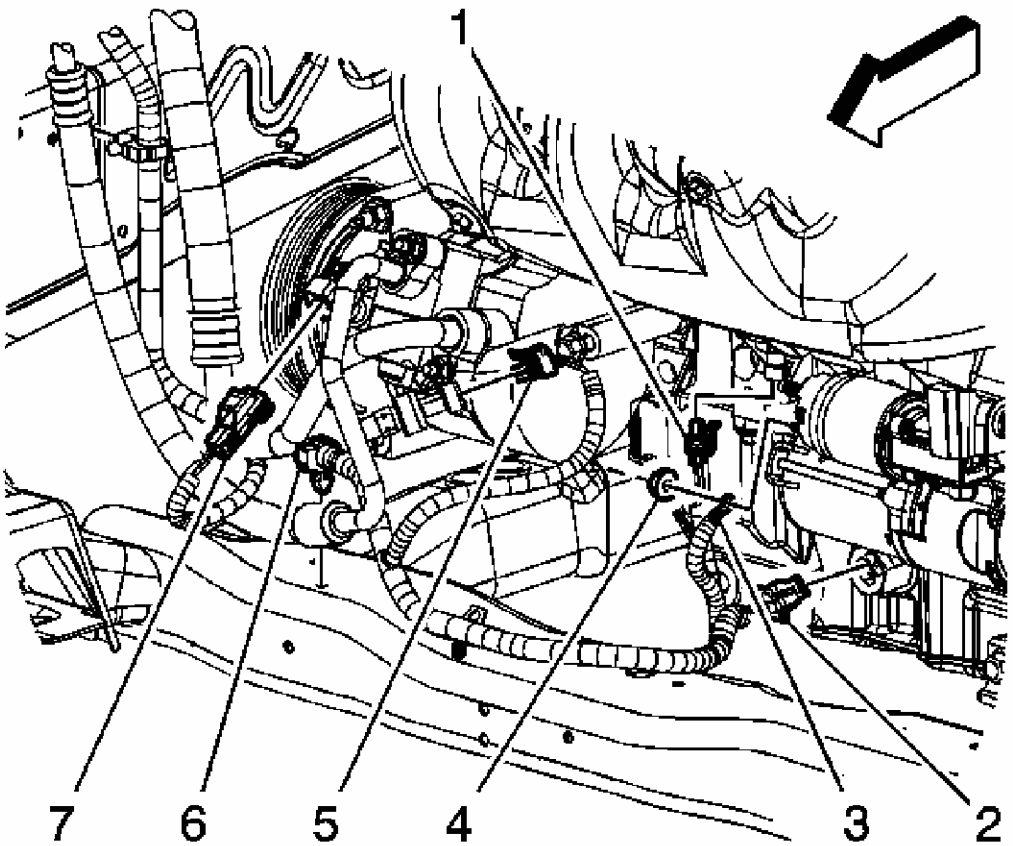


Fig. 70: Identifying Stater & Cable Components
Courtesy of GENERAL MOTORS CORP.

6. Remove the starter solenoid "S" terminal nut.
7. Remove the engine harness terminal (3) from the starter.

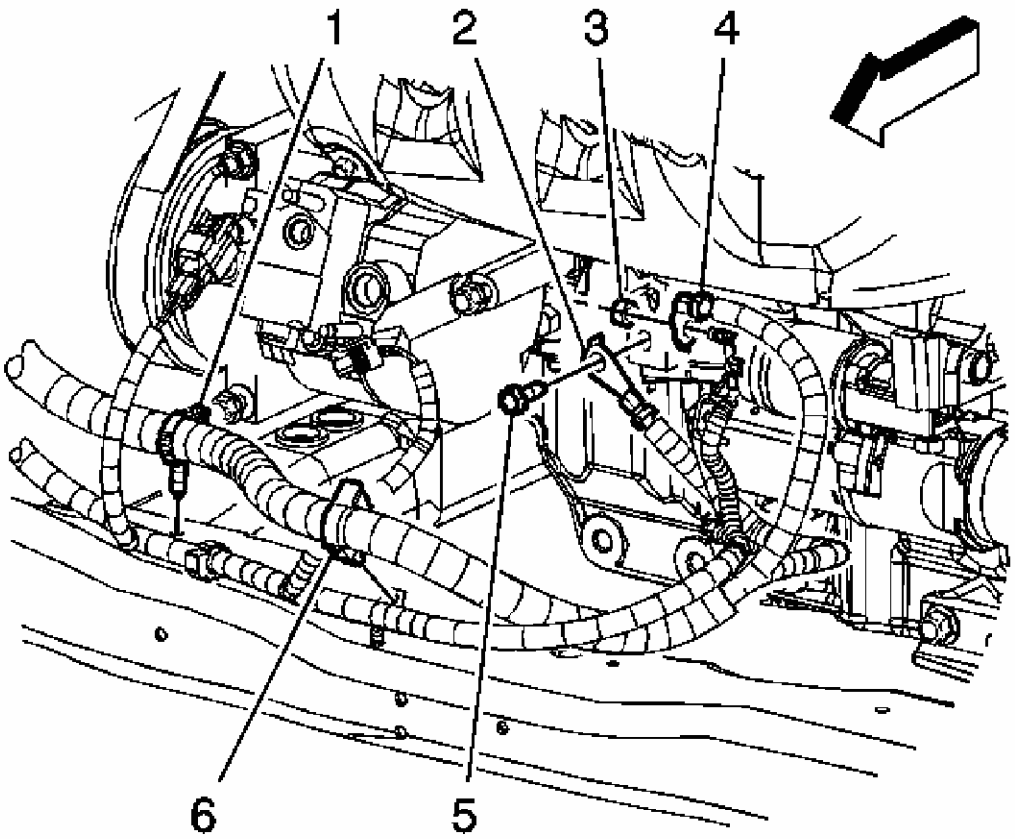


Fig. 71: Identifying Starter Solenoid & Starter Motor Cable Terminals
Courtesy of GENERAL MOTORS CORP.

8. Remove the starter solenoid "BAT" terminal nut (3).
9. Remove the starter cable terminal (4) from the starter.

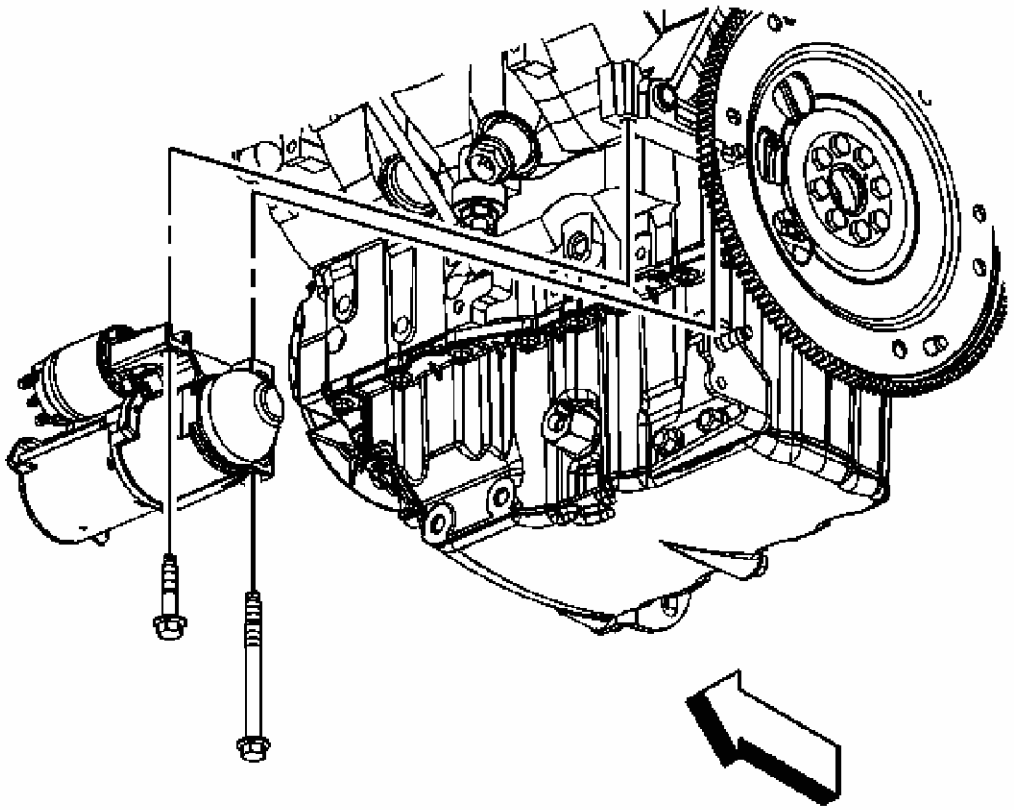


Fig. 72: Identifying Starter Motor & Bolts
Courtesy of GENERAL MOTORS CORP.

10. Remove the starter motor bolts.
11. Remove the starter motor.

Installation Procedure

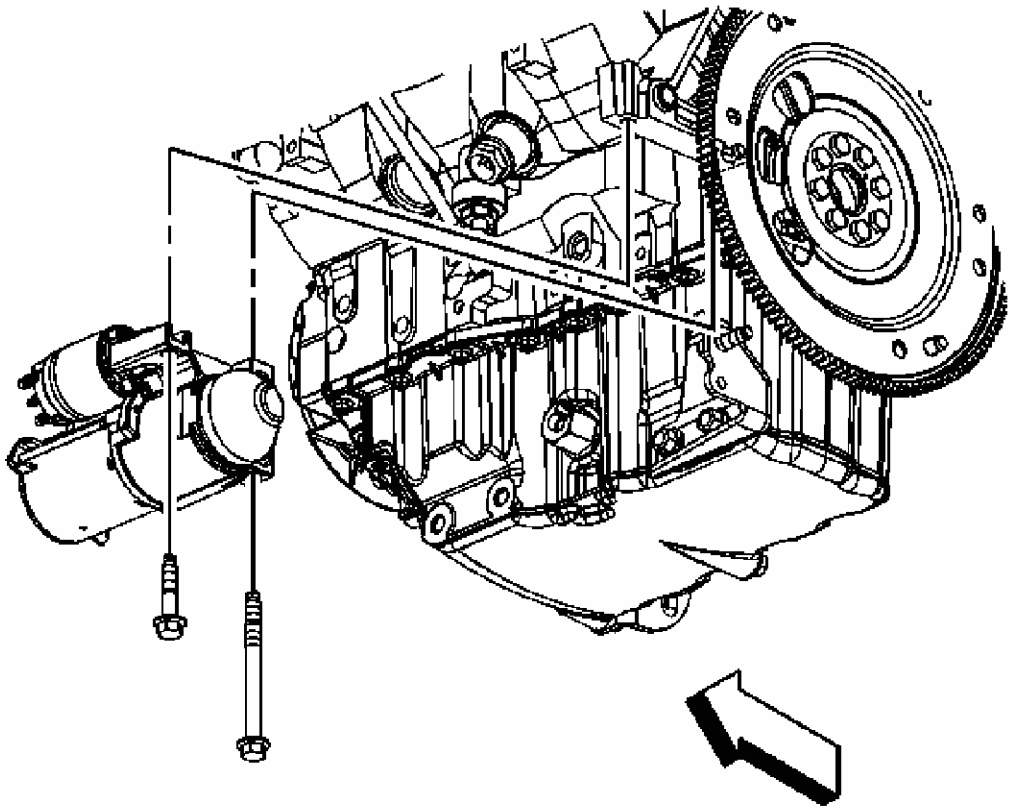


Fig. 73: Identifying Starter Motor & Bolts
Courtesy of GENERAL MOTORS CORP.

1. Position the starter motor to the engine.

NOTE: **Refer to Fastener Notice .**

2. Install the starter motor bolts.

Tighten: Tighten the bolts to 43 N.m (32 lb ft).

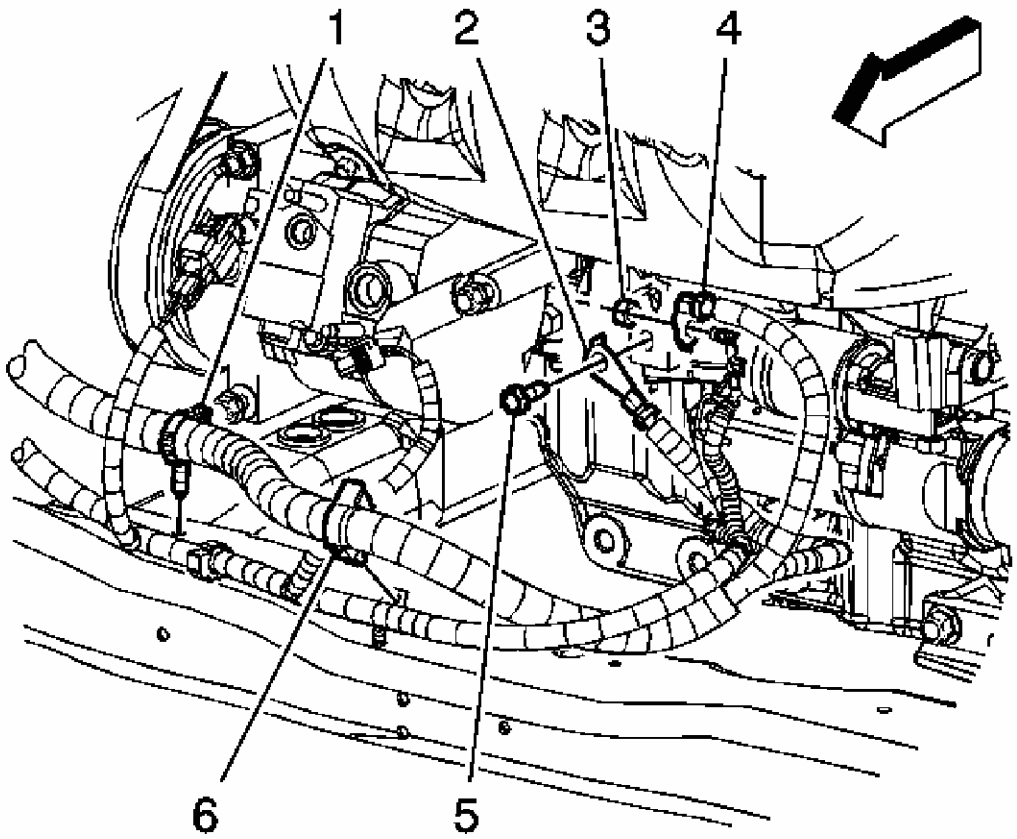


Fig. 74: Identifying Starter Solenoid & Starter Motor Cable Terminals
Courtesy of GENERAL MOTORS CORP.

3. Install the starter cable terminal (4) to the starter.
4. Install the starter solenoid "BAT" terminal nut (3).

Tighten: Tighten the nut to 10 N.m (89 lb in).

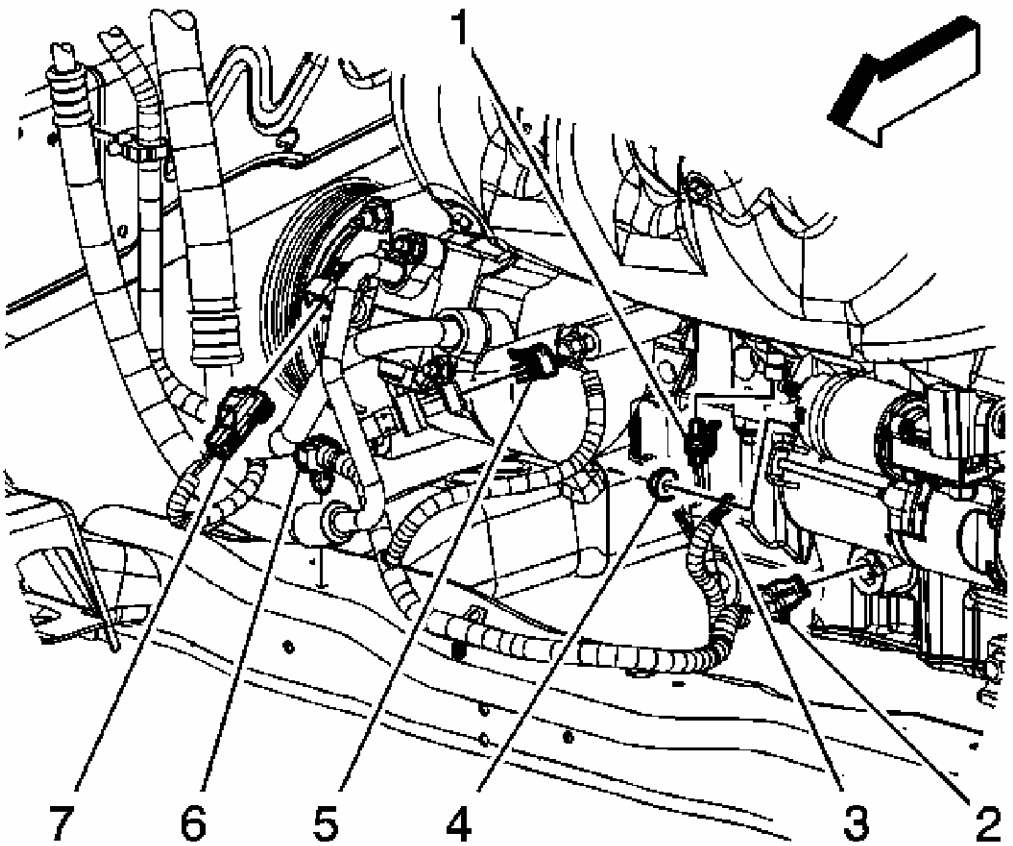


Fig. 75: Identifying Stater & Cable Components
Courtesy of GENERAL MOTORS CORP.

5. Install the engine harness terminal (3) to the starter.
6. Install the starter solenoid "S" terminal nut.

Tighten: Tighten the nut to 2.3 N.m (20.5 lb in).

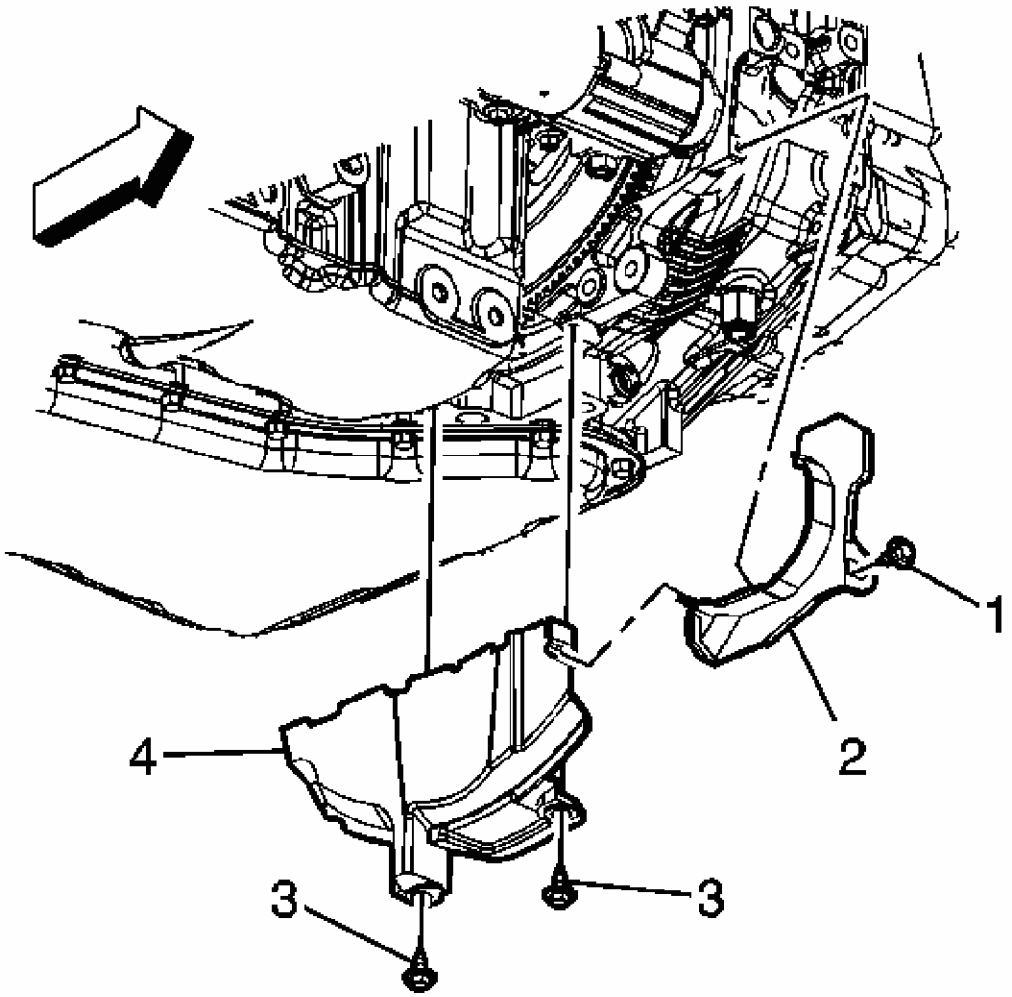


Fig. 76: Identifying Transaxle Converter Cover
Courtesy of GENERAL MOTORS CORP.

7. Install the transaxle converter cover (2).
8. Install the transaxle converter cover bolt (1).

   Tighten: Tighten the bolt to 7.5 N.m (66 lb in).

9. Install the transmission brace. Refer to **Automatic Transmission Brace Replacement (Converter Housing)** or **Automatic Transmission Brace Replacement (Extension Housing)** .
10. Lower the vehicle.
11. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection**

and Connection.

STARTER MOTOR REPLACEMENT (RPO LD8)

Removal Procedure

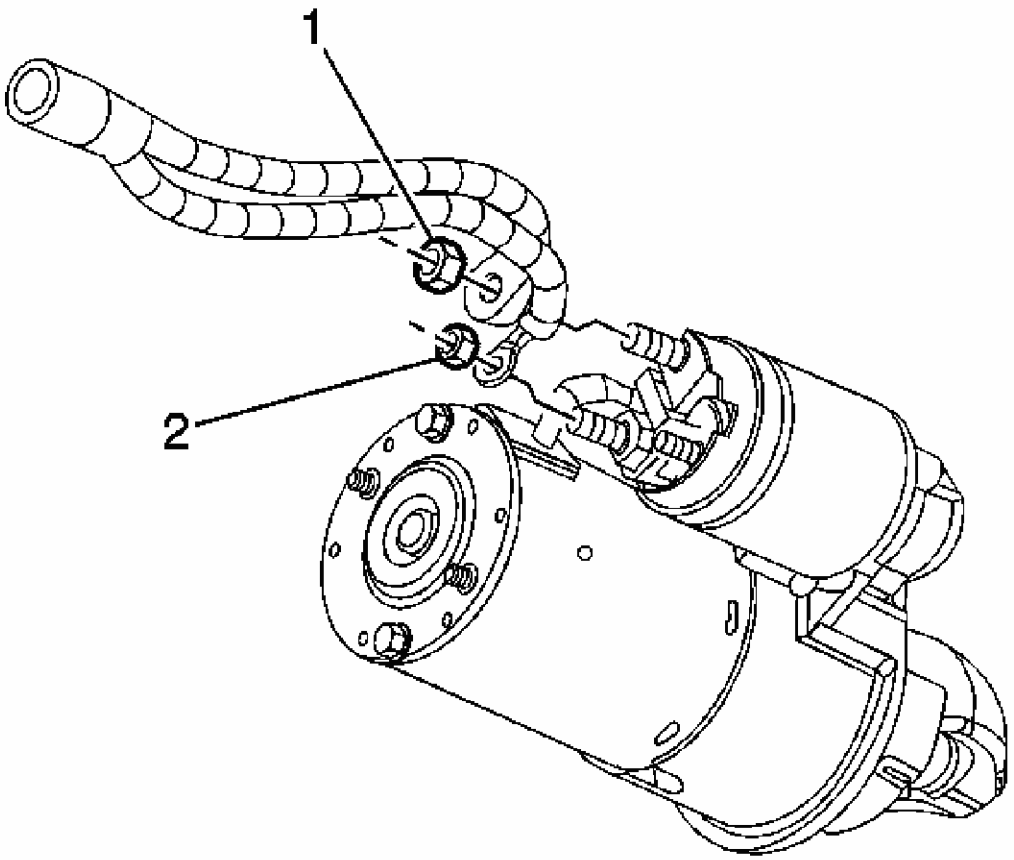


Fig. 77: Identifying "BAT" & "S" Terminals On Starter
Courtesy of GENERAL MOTORS CORP.

1. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection**.
2. Remove the intake manifold. Refer to **Intake Manifold Replacement** .
3. Remove the "BAT" terminal nut (1) from the starter.
4. Remove the "S" terminal nut (2) from the starter.
5. Remove the starter solenoid cable from the starter.

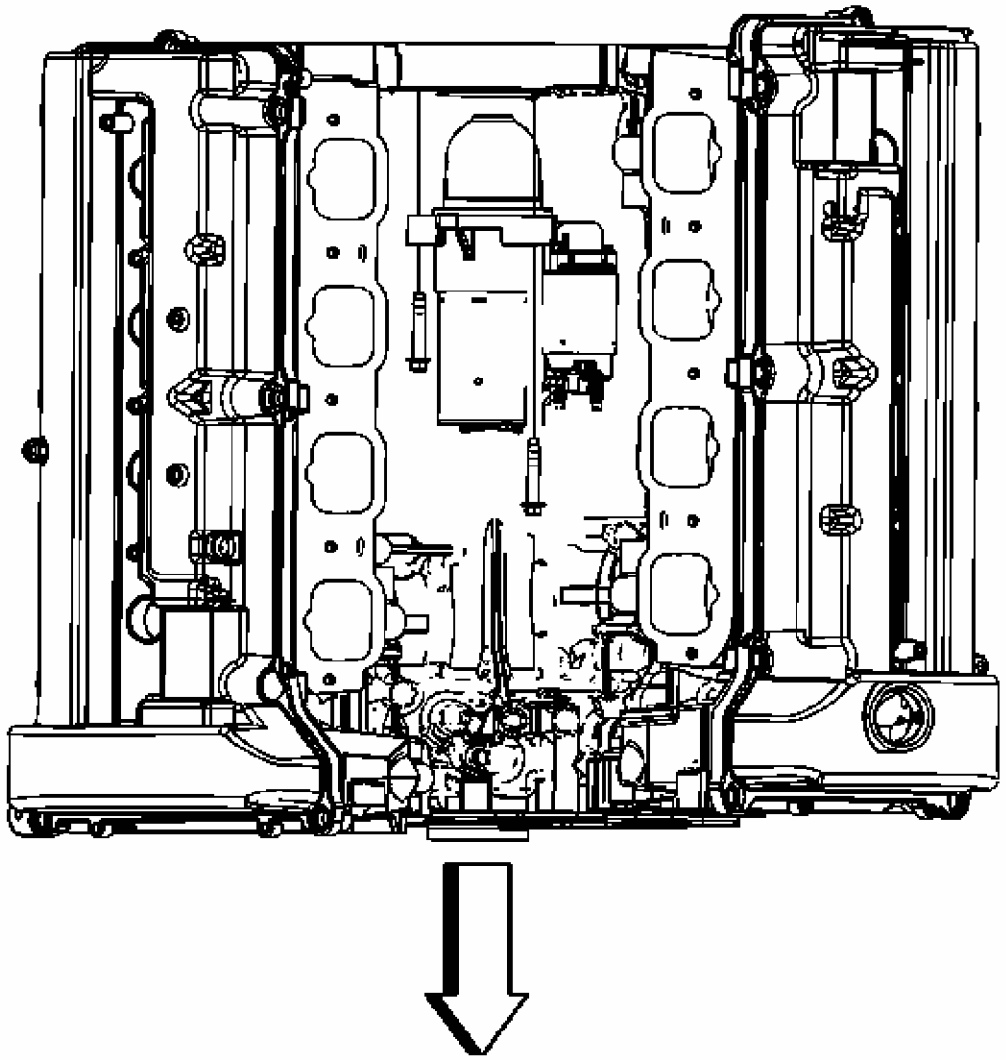


Fig. 78: Locating Starter
Courtesy of GENERAL MOTORS CORP.

6. Remove the starter motor bolts.
7. Remove the starter motor.

Installation Procedure

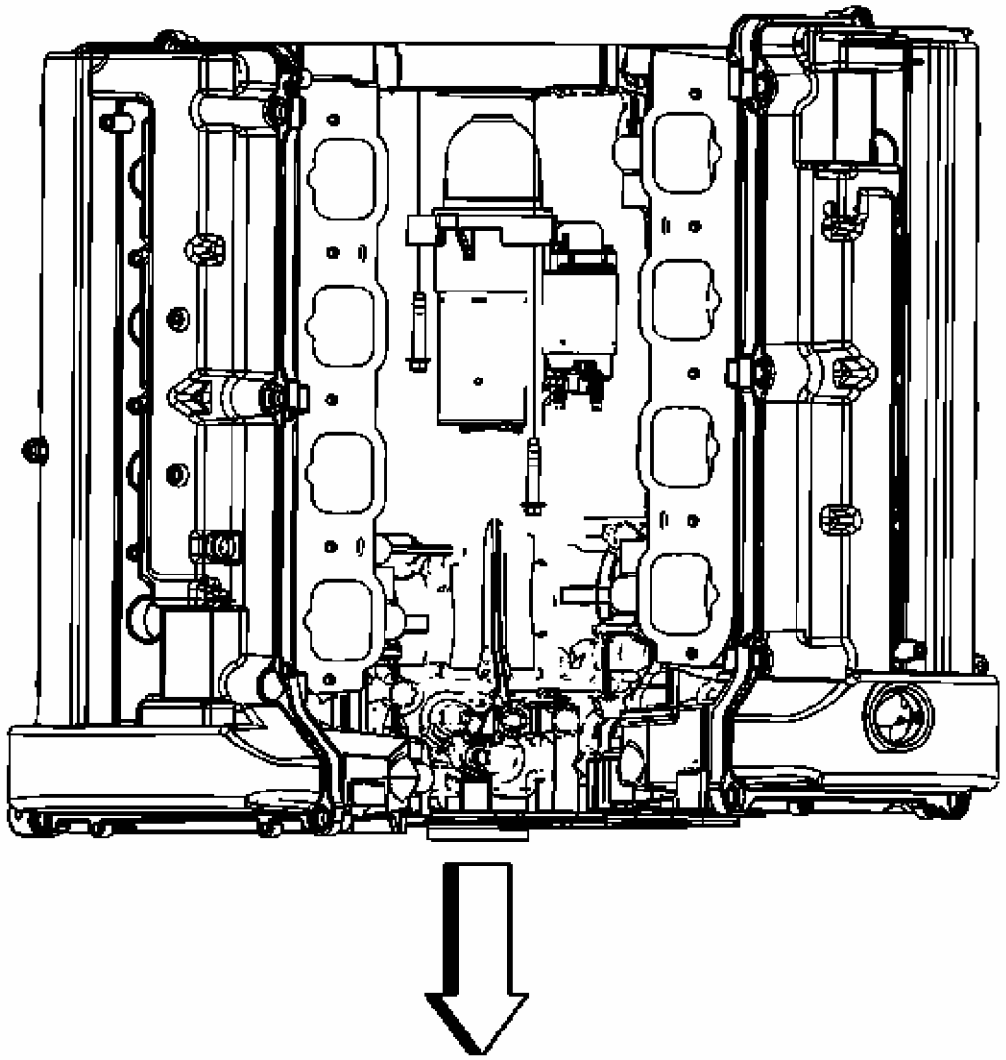


Fig. 79: Locating Starter
Courtesy of GENERAL MOTORS CORP.

1. Install the starter motor.

NOTE: Refer to Fastener Notice .

2. Install the starter motor bolts.

Tighten: Tighten the bolts to 25 N.m (18 lb ft).

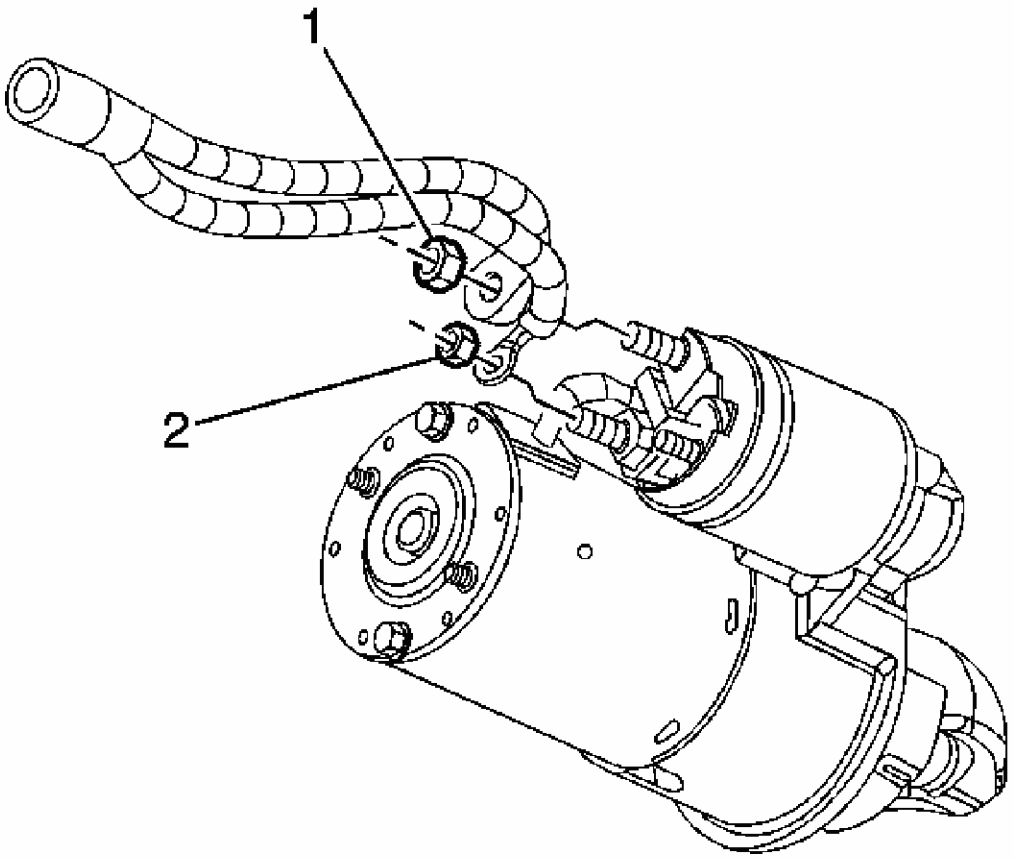


Fig. 80: Identifying "BAT" & "S" Terminals On Starter
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Ensure that the large terminal locator tab is placed into the starter solenoid retention slot.

3. Install the starter solenoid cable to the starter.
4. Install the "S" terminal nut (2) to the starter.

   Tighten: Tighten the nut to 4 N.m (35 lb in).

5. Install the "BAT" terminal nut (1) to the starter.

   Tighten: Tighten the nut to 10 N.m (89 lb in).

6. Install the intake manifold. Refer to **Intake Manifold Replacement** .
7. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection**

and Connection.

GENERATOR REPLACEMENT (RPO L26)

Removal Procedure

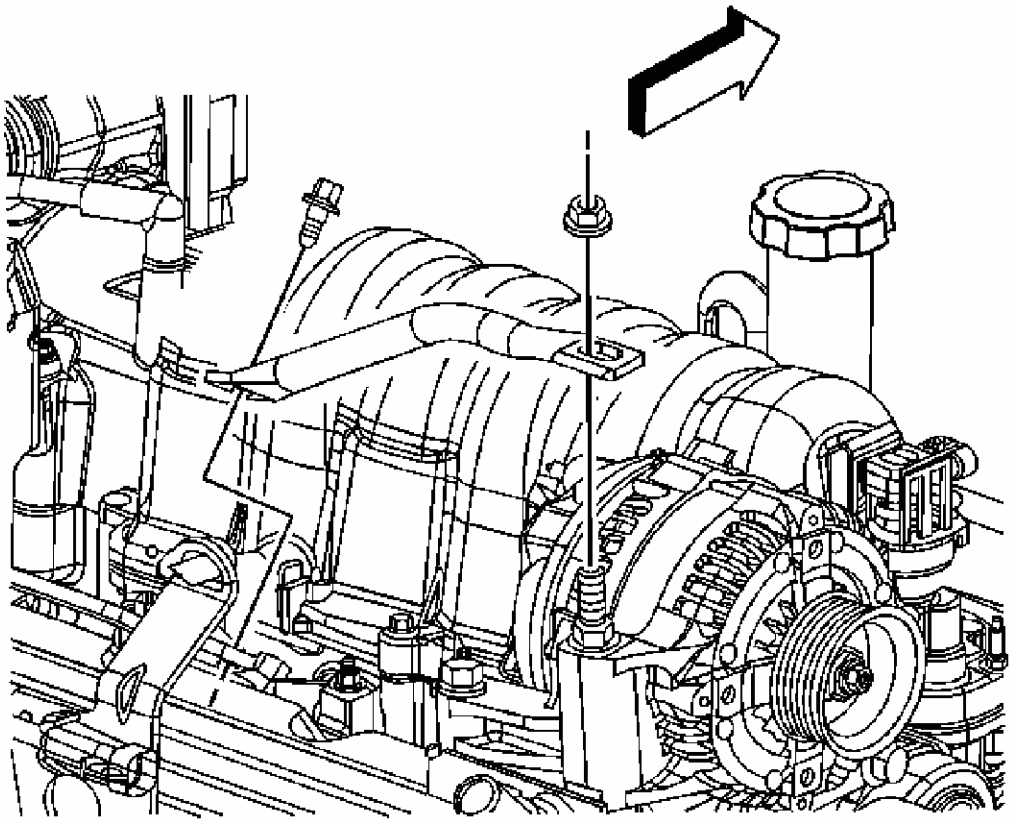


Fig. 81: Removing/Installing Generator Brace Bolt & Nut
Courtesy of GENERAL MOTORS CORP.

1. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection**.
2. Remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement** .
3. Remove the drive belt. Refer to **Drive Belt Replacement** .
4. Remove the generator brace bolt and nut.
5. Remove the generator brace.

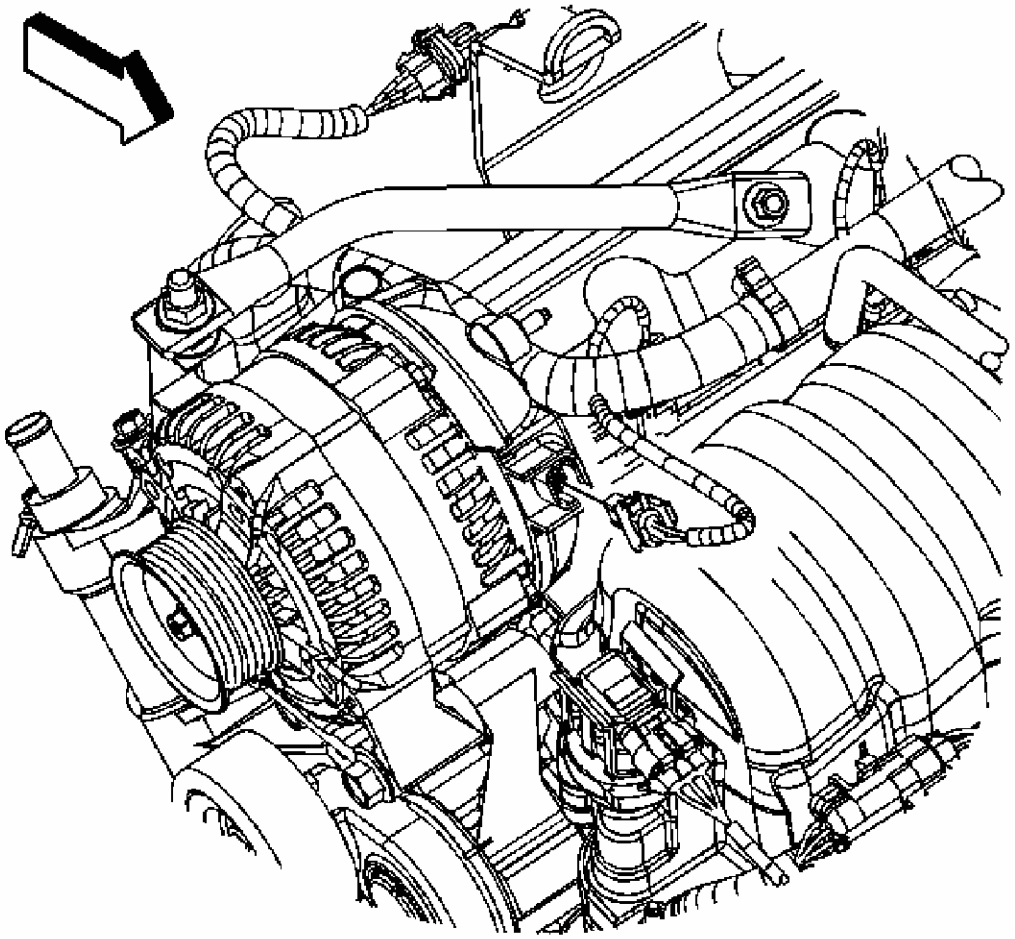


Fig. 82: Identifying Generator Harness Electrical Connector
Courtesy of GENERAL MOTORS CORP.

6. Disconnect the engine harness electrical connector from the generator.

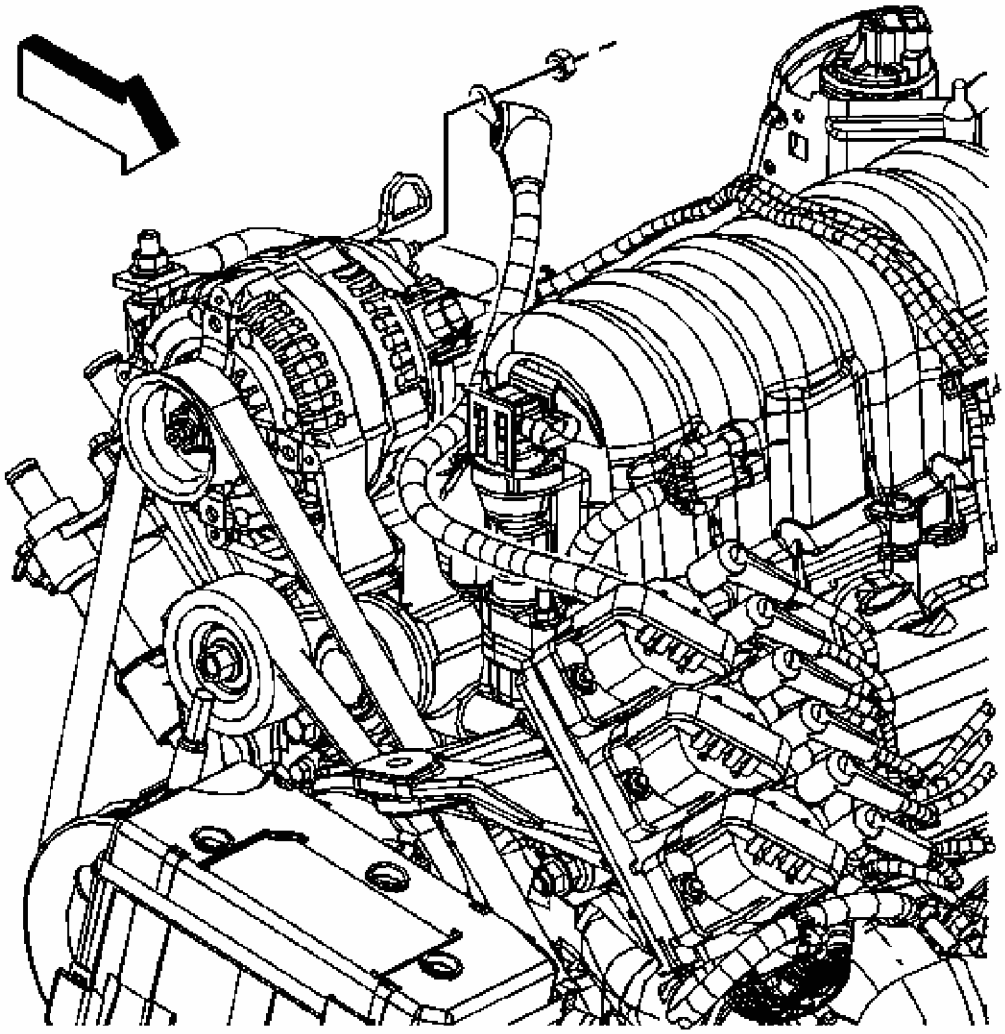


Fig. 83: Removing/Installing Generator Terminal Nut
Courtesy of GENERAL MOTORS CORP.

7. Reposition the starter cable boot.
8. Remove the generator terminal nut.
9. Remove the starter cable from the generator.

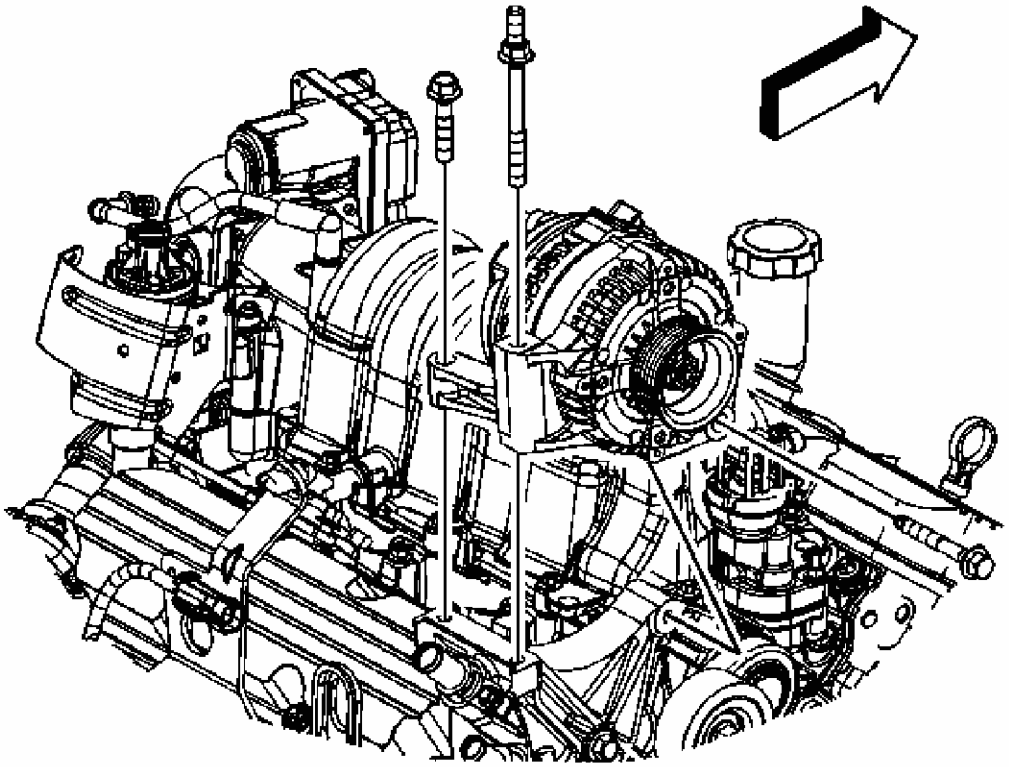


Fig. 84: Removing/Installing Generator
Courtesy of GENERAL MOTORS CORP.

10. Remove the generator front bolt.
11. Remove the generator rear bolt and stud.
12. Remove the generator.

Installation Procedure

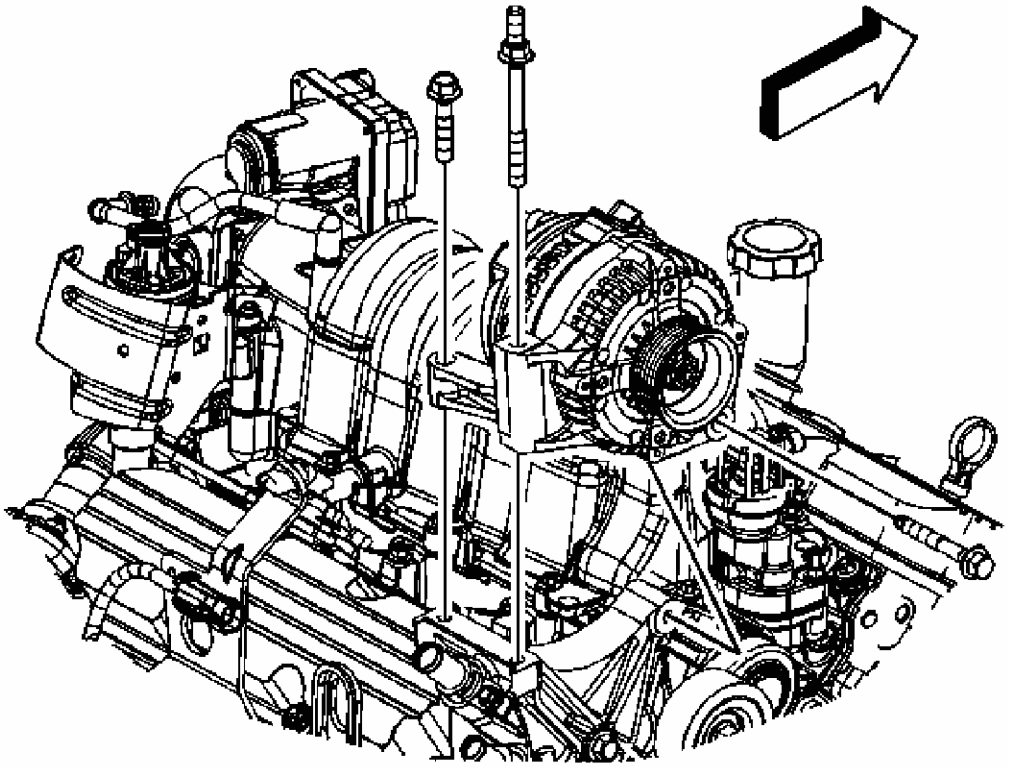


Fig. 85: Removing/Installing Generator
Courtesy of GENERAL MOTORS CORP.

1. Set the generator into position on the engine.
2. Install the generator front bolt.

NOTE: Refer to Fastener Notice .

3. Install the generator rear stud and bolt.

Tighten: Tighten the bolt/stud to 50 N.m (37 lb ft).

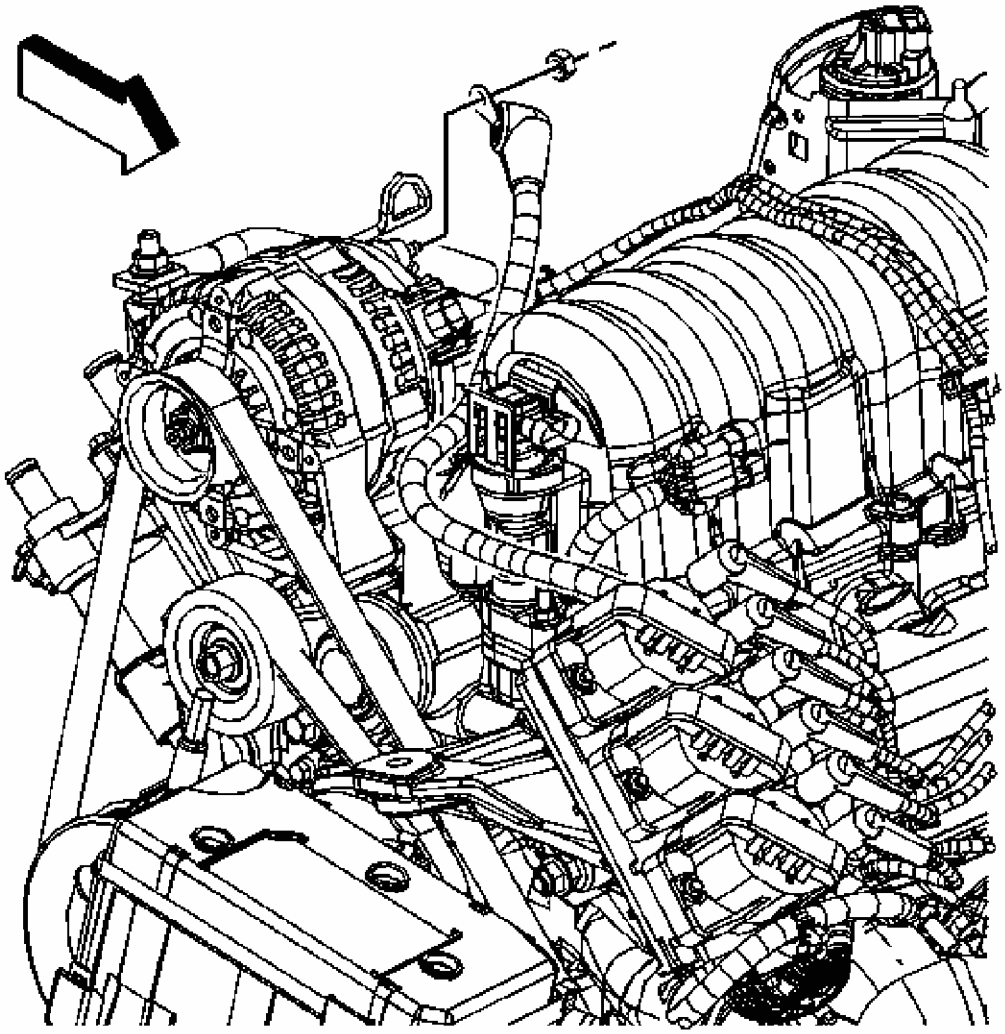


Fig. 86: Removing/Installing Generator Terminal Nut
Courtesy of GENERAL MOTORS CORP.

4. Install the starter cable to the generator.
5. Install the generator terminal nut.

   Tighten: Tighten the nut to 20 N.m (15 lb ft).

6. Position the starter cable boot.

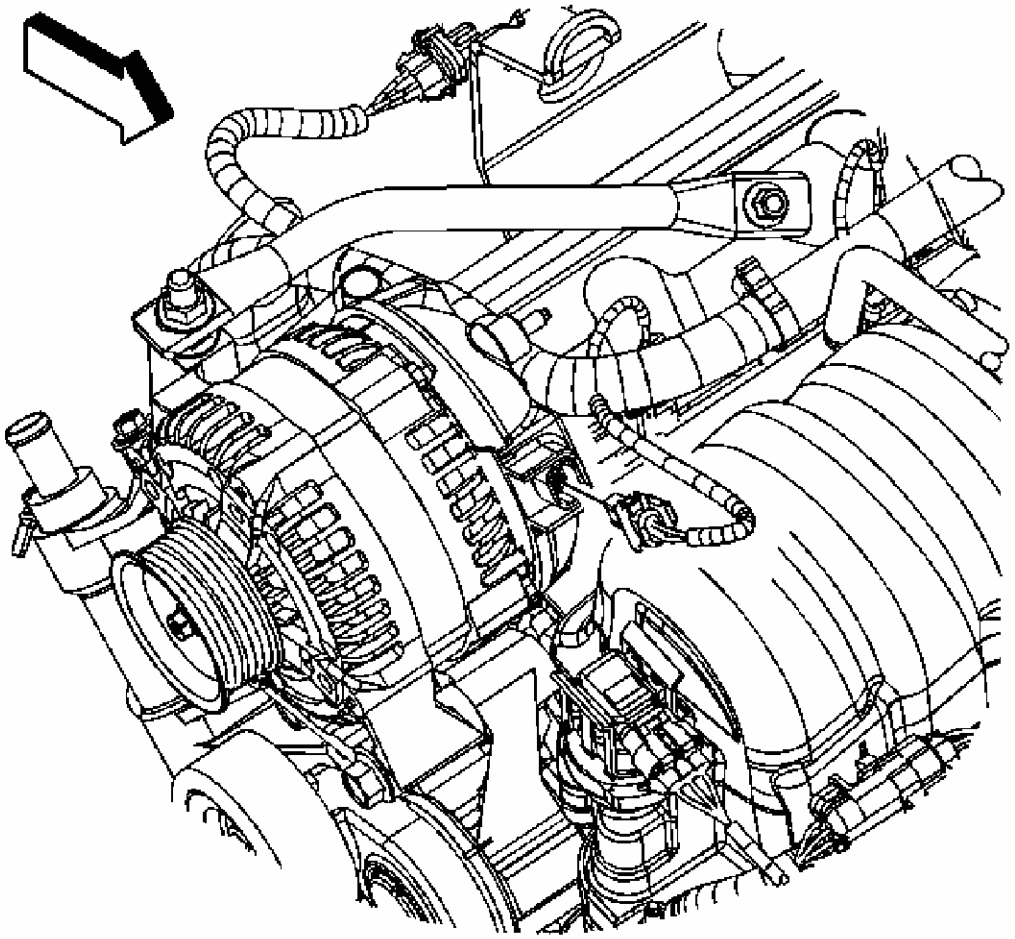


Fig. 87: Identifying Generator Harness Electrical Connector
Courtesy of GENERAL MOTORS CORP.

7. Connect the engine harness electrical connector to the generator.

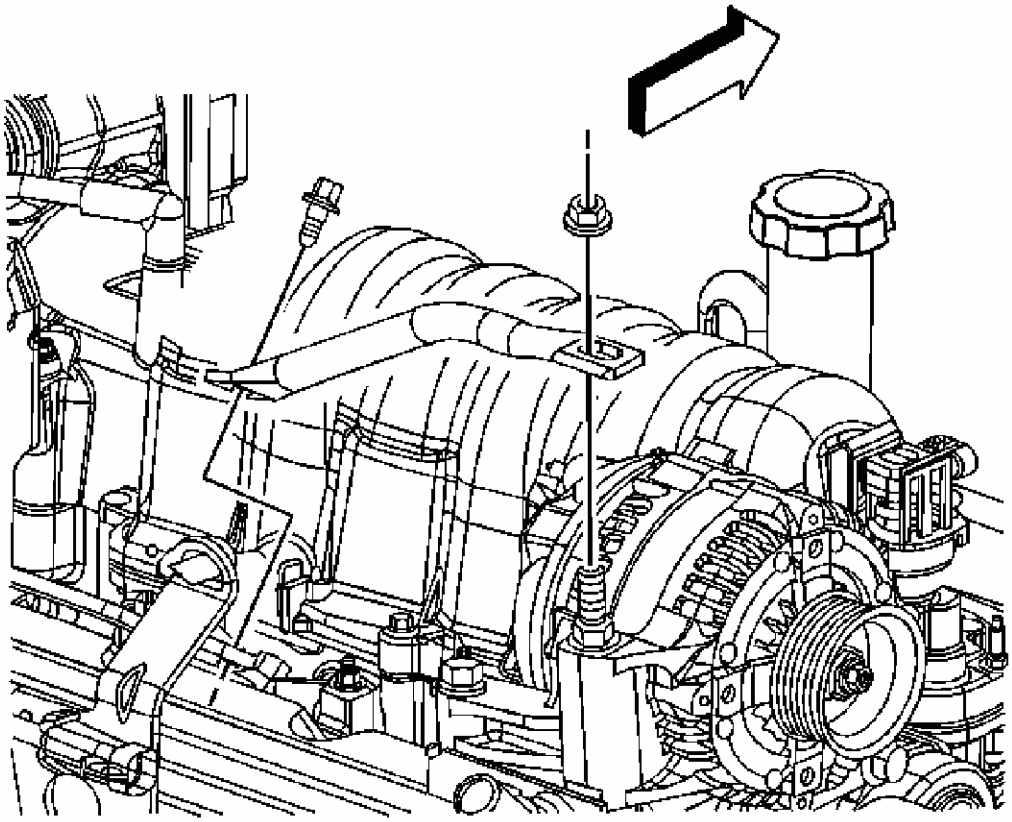


Fig. 88: Removing/Installing Generator Brace Bolt & Nut
Courtesy of GENERAL MOTORS CORP.

8. Install the generator brace.
9. Install the generator brace bolt and nut.

Tighten:

- Tighten the bolt to 25 N.m (18 lb ft).
- Tighten the nut to 50 N.m (37 lb ft).

10. Install the drive belt. Refer to **Drive Belt Replacement** .
11. Install the intake manifold cover. Refer to **Intake Manifold Cover Replacement** .
12. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection**.

GENERATOR REPLACEMENT (RPO LD8)

Removal Procedure

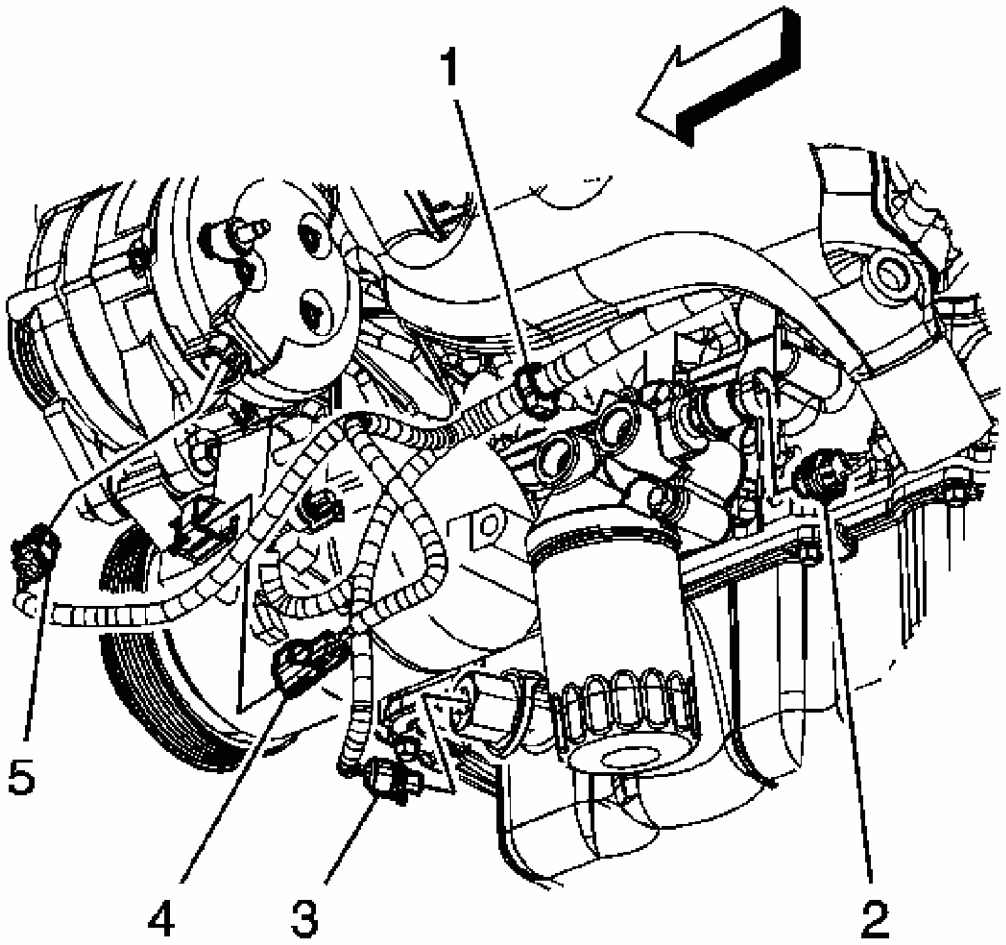


Fig. 89: Disconnecting/Connecting Engine Harness Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

1. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection**.
2. Remove the radiator. Refer to **Radiator Replacement (L26)** or **Radiator Replacement (LD8)** .
3. Remove the drive belt. Refer to **Drive Belt Replacement** .
4. Disconnect the engine wiring harness electrical connector (5) from the generator.

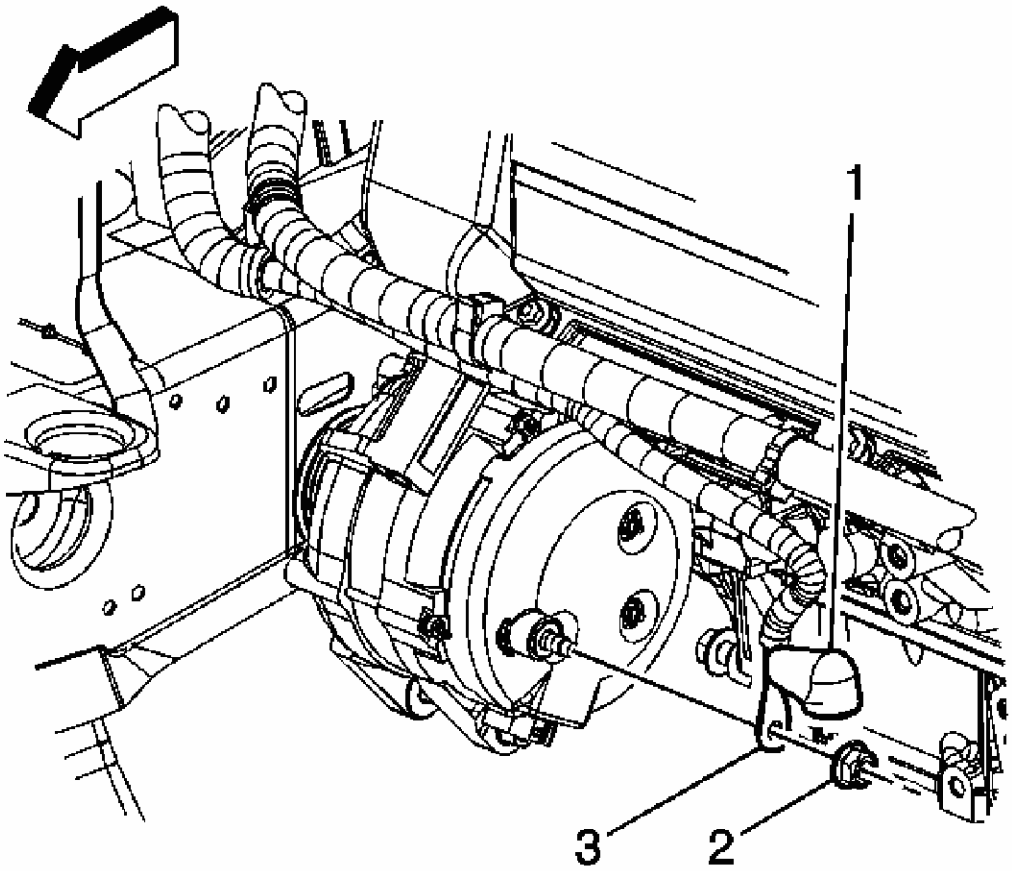


Fig. 90: Identifying Generator Terminal & Starter Solenoid Cable Terminal
Courtesy of GENERAL MOTORS CORP.

5. Reposition the starter solenoid cable protective boot (1) at the generator.
6. Remove the generator terminal nut (2).
7. Remove the starter solenoid cable terminal (3) from the generator.

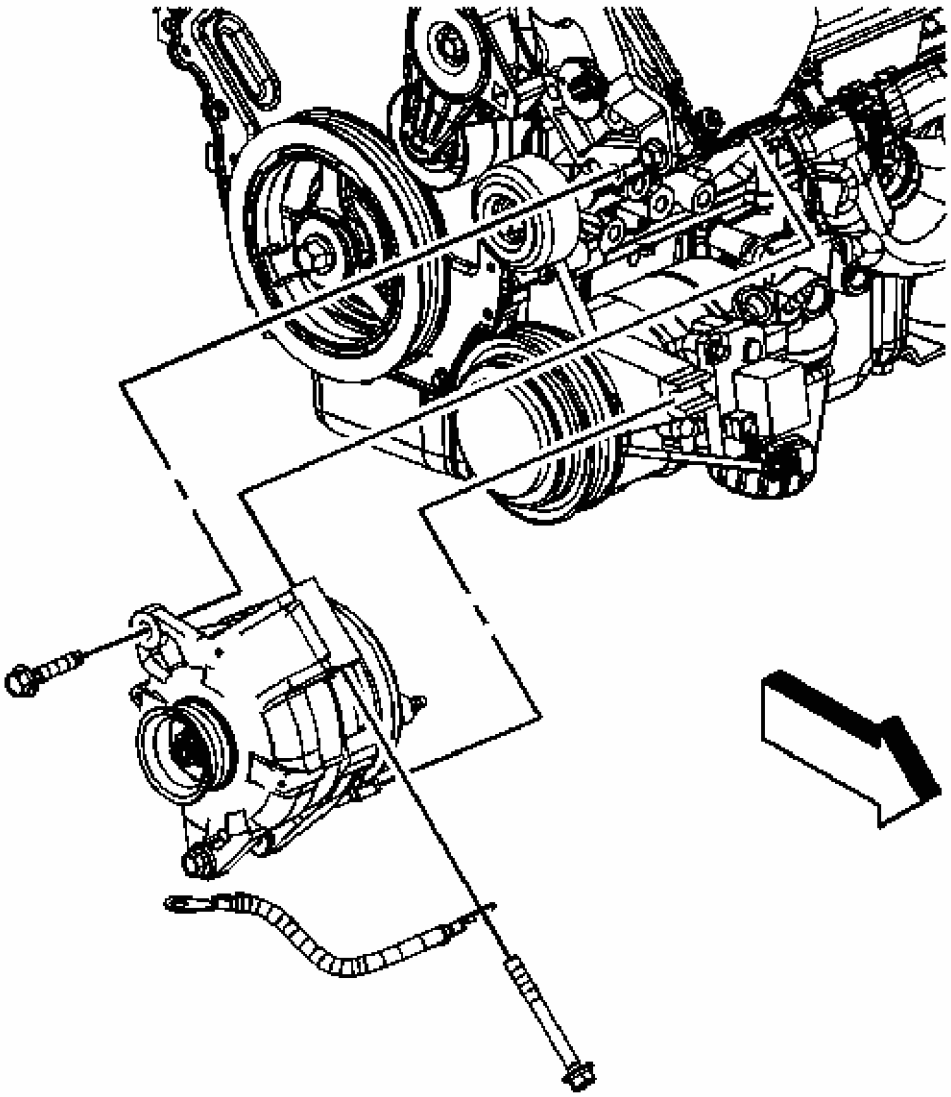


Fig. 91: Identifying Rear Generator Bolt & Ground Cable
Courtesy of GENERAL MOTORS CORP.

8. Remove the generator bolts.
9. Reposition the engine ground cable.
10. Remove the generator.

Installation Procedure

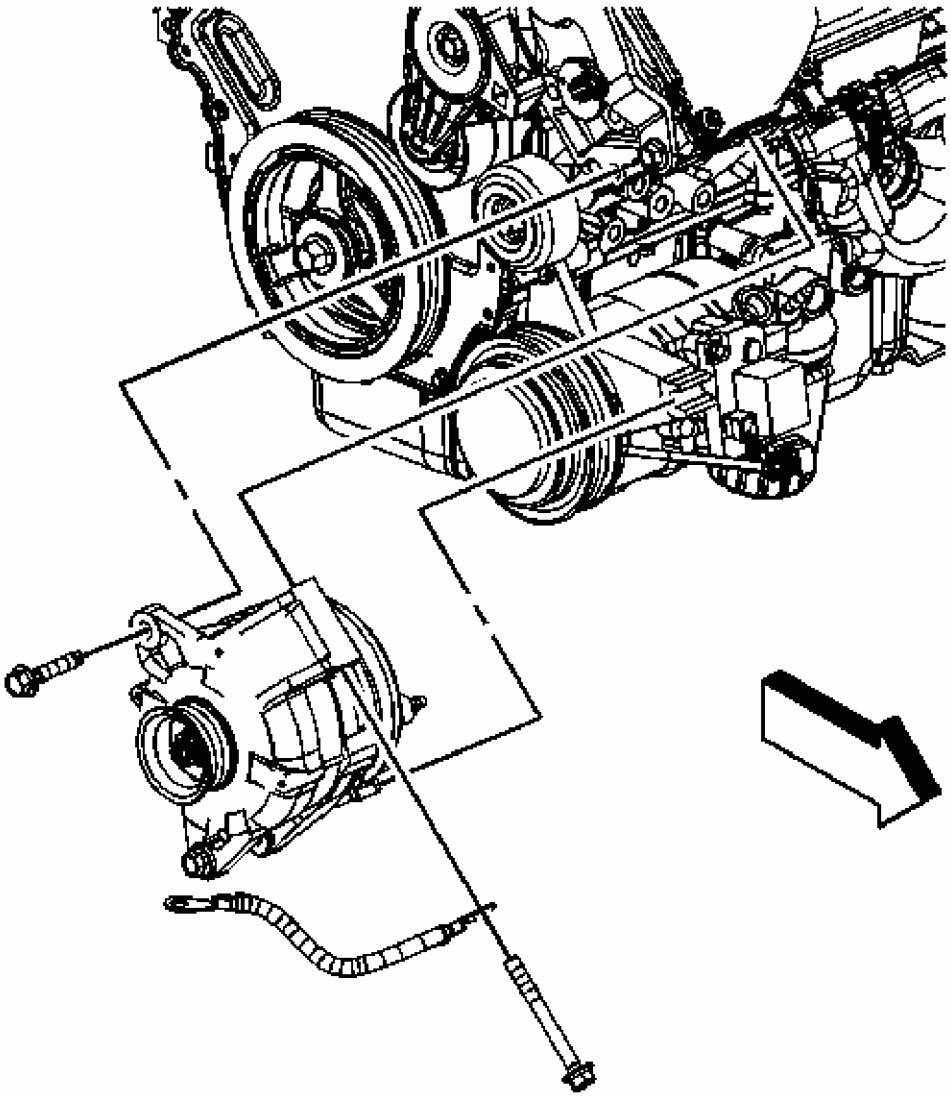


Fig. 92: Identifying Rear Generator Bolt & Ground Cable
Courtesy of GENERAL MOTORS CORP.

1. Position the generator to the engine.
2. Install the generator bolts finger tight in the following sequence.
    1. Upper bolt
    2. Side bolt
    3. Lower bolt

NOTE: **Refer to Fastener Notice .**

3. Tighten the generator bolts.

   Tighten: Tighten the bolts to 50 N.m (37 lb ft).

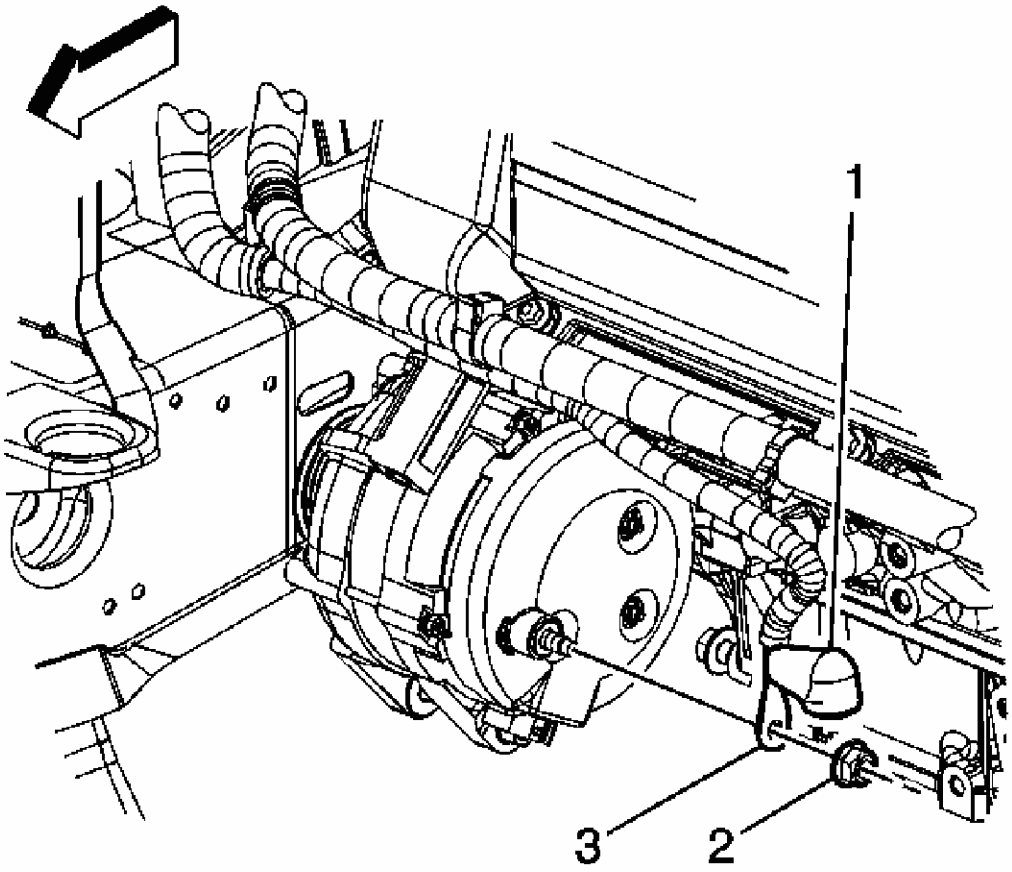


Fig. 93: Identifying Generator Terminal & Starter Solenoid Cable Terminal
Courtesy of GENERAL MOTORS CORP.

4. Install the starter solenoid cable terminal (3) to the generator.
5. Install the generator terminal nut (2).

   Tighten: Tighten the nut to 12 N.m (106 lb in).

6. Position the starter solenoid cable protective boot (1) at the generator.

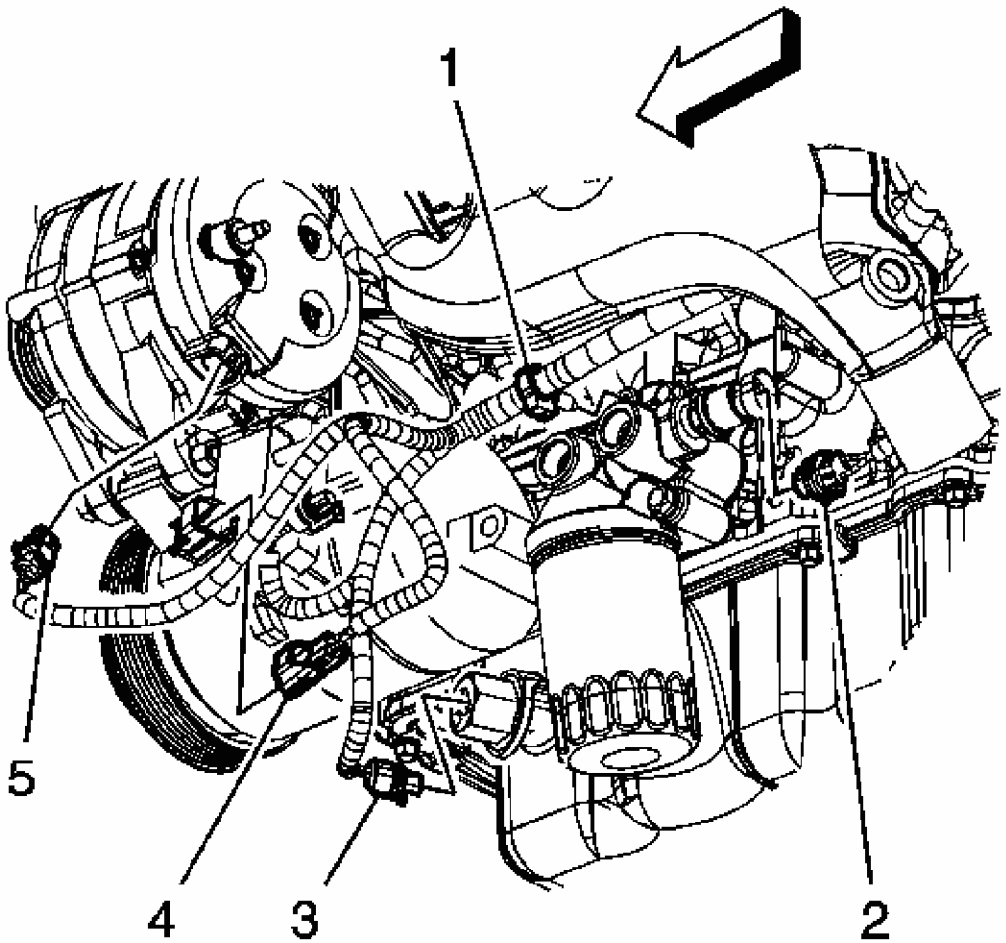


Fig. 94: Disconnecting/Connecting Engine Harness Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

7. Connect the engine wiring harness electrical connector (5) to the generator.
8. Install the drive belt. Refer to **Drive Belt Replacement** .
9. Install the radiator. Refer to **Radiator Replacement (L26)** or **Radiator Replacement (LD8)** .
10. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection**.

DESCRIPTION AND OPERATION

BATTERY DESCRIPTION AND OPERATION

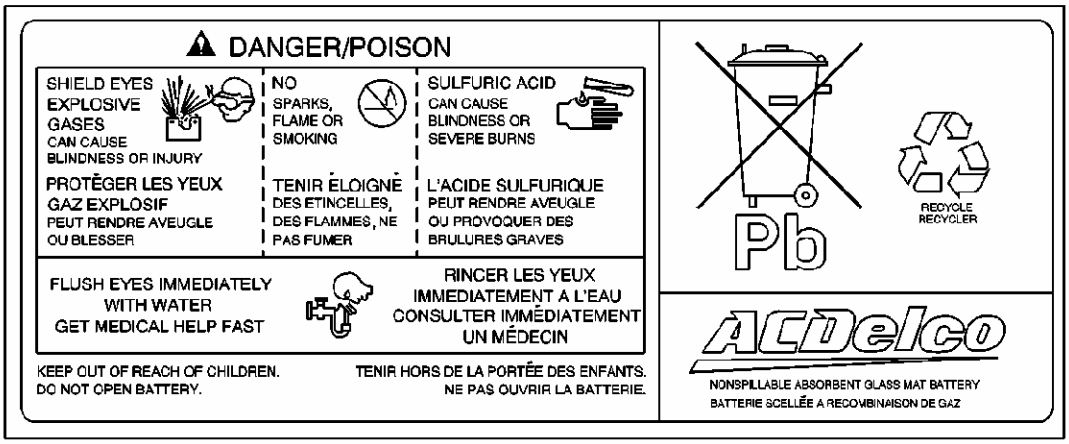


Fig. 95: Battery Warning Label
Courtesy of GENERAL MOTORS CORP.

CAUTION: Batteries produce explosive gases, contain corrosive acid and supply levels of electrical current high enough to cause burns. Therefore, to reduce the risk of personal injury when working near a battery:

- **Always shield your eyes and avoid leaning over the battery whenever possible.**
- **Do not expose the battery to open flames or sparks.**
- **Do not allow the battery electrolyte to contact the eyes or the skin. Flush immediately and thoroughly any contacted areas with water and get medical help.**
- **Follow each step of the jump starting procedure in order.**
- **Treat both the booster and the discharged batteries carefully when using the jumper cables.**

IMPORTANT: Because of the materials used in the manufacture of automotive lead-acid batteries, dealers and service shops that handle them are subject to various regulations issued by OSHA, EPA, DOT and various state or local agencies. Other regulations may also apply in other locations. Always know and follow these regulations when handling batteries.

Batteries that are no longer wanted must be disposed of by an approved battery recycler and must never be thrown in the trash or sent to a landfill.

Batteries that are not part of the vehicle itself, not the battery under the hood, must only be transported on public streets for business purposes via approved hazardous material transportation procedures.

Battery storage, charging and testing facilities in repair shops must meet various requirements for ventilation, safety equipment, material segregation, etc.

The maintenance-free battery is standard. There are no vent plugs in the cover. The battery is completely sealed except for 2 small vent holes in the side. These vent holes allow the small amount of gas that is produced in the battery to escape.

The battery has 3 functions as a major source of energy:

- Engine cranking
- Voltage stabilizer
- Alternate source of energy with generator overload

The battery specification label, example below, contains information about the following:

- The test ratings
- The original equipment catalog number
- The recommended replacement model number

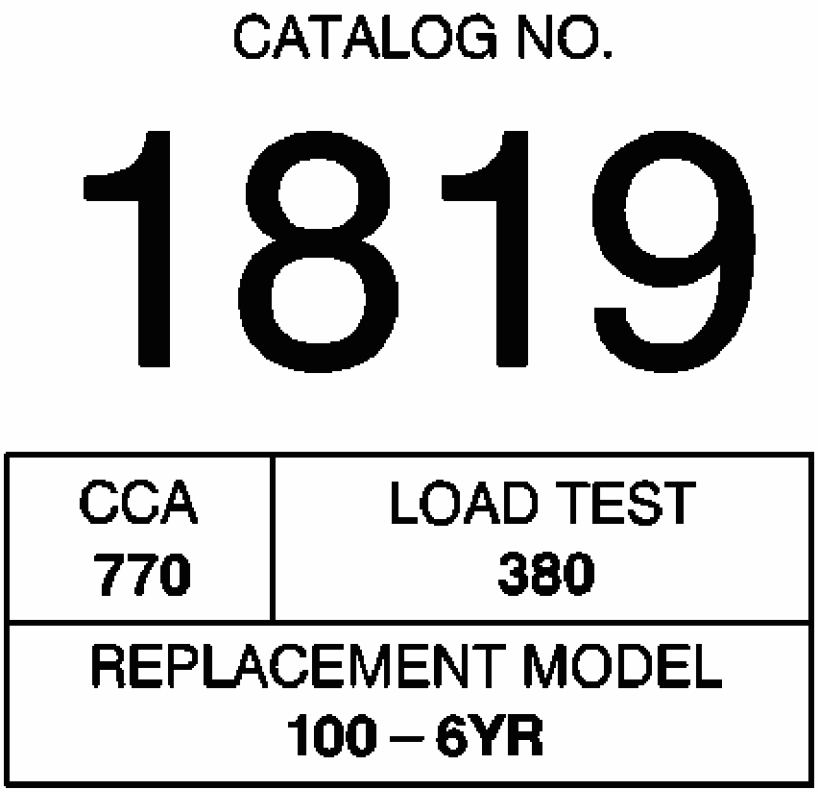


Fig. 96: View Of Battery Specification Label
Courtesy of GENERAL MOTORS CORP.

Battery Ratings

A battery may have 3 ratings:

- Amp hour
- Reserve capacity
- Cold cranking amperage

When a battery is replaced, use a battery with similar ratings. Refer to the battery specification label on the original battery or refer to **Battery Usage**.

Amp Hour

The amp hour rating of a battery is the amount of time it takes a fully charged battery, being discharged at a constant rate of 1 amperes and a constant temperature of 27°C (80°F), to reach

a terminal voltage of 10.5 volts. Refer to **Battery Usage** for the amp hour rating of the original equipment battery.

Reserve Capacity

Reserve capacity is the amount of time in minutes it takes a fully charged battery, being discharged at a constant rate of 25 amperes and a constant temperature of 27°C (80°F), to reach a terminal voltage of 10.5 volts. Refer to **Battery Usage** for the reserve capacity rating of the original equipment battery.

Cold Cranking Amperage

The cold cranking amperage is an indication of the ability of the battery to crank the engine at cold temperatures. The cold cranking amperage rating is the minimum amperage the battery must maintain for 30 seconds at -18°C (0°F) while maintaining at least 7.2 volts. Refer to **Battery Usage** for the cold cranking amperage rating for this vehicle.

CHARGING SYSTEM DESCRIPTION AND OPERATION

Electrical Power Management (EPM) Overview

The electrical power management (EPM) system is designed to monitor and control the charging system and send diagnostic messages to alert the driver of possible problems with the battery and generator. This EPM system primarily utilizes existing on-board computer capability to maximize the effectiveness of the generator, to manage the load, improve battery state-of-charge and life and minimize the system's impact on fuel economy. The EPM system performs 3 functions:

- It monitors the battery voltage and estimates the battery condition.
- It takes corrective actions by boosting idle speeds and adjusting the regulated voltage.
- It performs diagnostics and driver notification.

The battery condition is estimated during ignition-off and during ignition-on. During ignition-off the state-of-charge (SOC) of the battery is determined by measuring the open-circuit voltage. The SOC is a function of the acid concentration and the internal resistance of the battery and is estimated by reading the battery open circuit voltage when the battery has been at rest for several hours.

The SOC can be used as a diagnostic tool to tell the customer or the dealer the condition of the battery. Throughout ignition-on, the algorithm continuously estimates SOC based on adjusted net amp hours, battery capacity, initial SOC and temperature.

While running, the battery degree of discharge is primarily determined by a battery current sensor, which is integrated to obtain net amp hours.

In addition, the EPM function is designed to perform regulated voltage control (RVC) to improve battery SOC, battery life and fuel economy. This is accomplished by using knowledge of the battery SOC and temperature to set the charging voltage to an optimum battery voltage level for recharging without detriment to battery life.

The Charging System Description and Operation is divided into 3 areas. The first area describes the charging system components and their integration into the EPM. The second area describes charging system operation. The third area describes the instrument panel cluster (IPC) operation of the charge indicator, driver information center (DIC) messages and voltmeter operation.

Charging System Components

Generator

The generator is a serviceable component. If there is a diagnosed failure of the generator it must be replaced as an assembly. The engine drive belt drives the generator. When the rotor is spun it induces an alternating current (AC) into the stator windings. The AC voltage is then sent through a series of diodes for rectification. The rectified voltage has been converted into a direct current (DC) for use by the vehicles electrical system to maintain electrical loads and the battery charge. The voltage regulator integral to the generator controls the output of the generator. It is not serviceable. The voltage regulator controls the amount of current provided to the rotor. If the generator has field control circuit failure, the generator defaults to an output voltage of 13.8 volts.

Body Control Module (BCM)

The body control module (BCM) is a GMLAN device. It communicates with the engine control module (ECM) and the instrument panel cluster (IPC) for electrical power management (EPM) operation. The BCM determines the output of the generator and sends the information to the ECM for control of the generator field control circuit. It monitors the generator field duty cycle signal circuit information sent from the ECM for control of the generator. It monitors a battery current sensor, the battery positive voltage circuit and estimated battery temperature to determine battery state of charge (SOC). The BCM performs idle boost.

Battery Current Sensor

The battery current sensor is a serviceable component that is connected to the negative battery cable at the battery. The battery current sensor is a 3-wire hall effect current sensor. The battery current sensor monitors the battery current. It directly inputs to the BCM. It creates a 5-volt pulse width modulation (PWM) signal of 128 Hz with a duty cycle of 0-100 percent. Normal duty cycle is between 5-95 percent. Between 0-5 percent and 95-100 percent are for diagnostic purposes.

Engine Control Module (ECM)

The ECM directly controls the generator field control circuit input to the generator. The ECM receives control decisions based on messages from the BCM. It monitors the generators generator field duty cycle signal circuit and sends the information to the BCM.

Instrument Panel Cluster (IPC)

The IPC provides a means of customer notification in case of a failure and a voltmeter. There are 2 means of notification, a charge indicator and a driver information center (DIC) message of SERVICE BATTERY CHARGING SYSTEM.

Charging System Operation

The purpose of the charging system is to maintain the battery charge and vehicle loads. There are 6 modes of operation and they include:

- Battery Sulfation Mode
- Charge Mode
- Fuel Economy Mode
- Headlamp Mode
- Start Up Mode
- Voltage Reduction Mode

The engine control module (ECM) controls the generator through the generator field control circuit. It monitors the generator performance though the generator field duty cycle signal circuit. The ECM controls the generator through the generator field control circuit. The signal is a 5-volt pulse width modulation (PWM) signal of 128 Hz with a duty cycle of 0-100 percent. Normal duty cycle is between 5-95 percent. Between 0-5 percent and 95-100 percent are for diagnostic purposes. The following table shows the commanded duty cycle and output voltage of the generator:

Charging System Description and Operation

Commanded Duty Cycle	Generator Output Voltage
10%	11 V
20%	11.56 V
30%	12.12 V
40%	12.68 V
50%	13.25 V
60%	13.81 V
70%	14.37 V
80%	14.94 V
90%	15.5 V

The generator provides a feedback signal of the generator voltage output through the generator field duty cycle signal circuit to the ECM. This information is sent to the body control module (BCM). The signal is a 5-volt PWM signal of 128 Hz with a duty cycle of 0-100 percent. Normal duty cycle is between 5-99 percent. Between 0-5 percent and 100 percent are for diagnostic purposes.

Battery Sulfation Mode

The BCM will enter this mode when the interpreted generator output voltage is less than 13.2 volts for 45 minutes. When this condition exists the BCM will enter Charge Mode for 2-3 minutes. The BCM will then determine which mode to enter depending on voltage requirements.

Charge Mode

The BCM will enter Charge Mode when ever one of the following conditions are met.

- The wipers are ON for than 3 seconds.
- GMLAN (Climate Control Voltage Boost Mode Request) is true, as sensed by the HVAC control head. High speed cooling fan, rear defogger and HVAC high speed blower operation can cause the BCM to enter the Charge Mode.
- The estimated battery temperature is less than 0°C (32°F).
- Battery State of Charge is less than 80 percent.
- Vehicle Speed is greater than 145 kph (90 mph)
- Current Sensor Fault Exists
- System Voltage was determined to be below 12.56 volts

When any one of these conditions is met, the system will set targeted generator output voltage to a charging voltage between 13.9-15.5 volts, depending on the battery state of charge and estimated battery temperature.

Fuel Economy Mode

The BCM will enter Fuel Economy Mode when the estimated battery temperature is at least 0° C (32°F) but less than or equal to 80°C (176°F), the calculated battery current is less than 15 amps and greater than -8 amps and the battery state of charge (SOC) is greater than or equal to 80 percent. Its targeted generator output voltage is the open circuit voltage of the battery and can be between 12.5-13.1 volts. The BCM will exit this mode and enter Charge Mode when any of the conditions described above are present.

Headlamp Mode

The BCM will enter Headlamp Mode when ever the headlamps are ON (high or low beams). Voltage will be regulated between 13.9-14.5 volts

Start Up Mode

When the engine is started the BCM sets a targeted generator output voltage of 14.5 volts for 30 seconds.

Voltage Reduction Mode

The BCM will enter Voltage Reduction Mode when the calculated ambient air temperature is above 0°C (32°F). The calculated battery current is less than 1 amp and greater than -7 amps and the generator field duty cycle is less than 99 percent. Its targeted generator output voltage is 12.9 volts. The BCM will exit this mode once the criteria are met for Charge Mode.

Instrument Panel Cluster (IPC) Operation

Charge Indicator Operation

The instrument panel cluster (IPC) illuminates the charge indicator and displays a warning message in the driver information center (DIC) when the one or more of the following occurs:

- The engine control module (ECM) detects that the generator output is less than 11 volts or greater than 16 volts. The IPC receives a GMLAN message from the ECM requesting illumination.
- The IPC determines that the system voltage is less than 11 volts or greater than 16 volts for more than 30 seconds. The IPC receives a GMLAN message from the body control module (BCM) indicating there is a system voltage range concern.
- The IPC performs the displays test at the start of each ignition cycle. The indicator illuminates for approximately 3 seconds.

SERVICE BATTERY CHARGING SYSTEM

The BCM and the ECM will send a GMLAN message to the DIC for the SERVICE BATTERY CHARGING SYSTEM message to be displayed. It is commanded ON when a charging system DTC is a current DTC. The message is turned OFF when the conditions for clearing the DTC have been met.

ELECTRICAL POWER MANAGEMENT DESCRIPTION AND OPERATION

Electrical Power Management

The electrical power management (EPM) is used to monitor and control the charging system and alert the driver of possible problems within the charging system. The EPM system makes the most efficient use of the generator output, improves the battery state of charge (SOC), extends battery life.

The idle boost operation is a means of improving generator performance during a low voltage or low battery SOC condition.

Idle boost is activated in incremental steps, idle boost 1 must be active before idle boost 2 can be active. The criteria used by the body control module (BCM) to regulate EPM are outlined below.

Electrical Power Management Description and Operation

Function	Battery Temperature Calculation	Battery Voltage Calculation	Amp-hour Calculation	Action Taken
Idle Boost 1 Start	Less Than -15°C (5°F)	Less Than 13 V	-	First level Idle boost requested
Idle Boost 1 Start	-	-	Battery has a net loss greater than 0.6 AH	First level Idle boost requested
Idle Boost 1 Start	-	Less Than 10.9 V	-	First level Idle boost requested
Idle Boost 1 End	Greater Than -10°C (5°F)	Greater Than 12 V	Battery has a net loss less than 0.2 AH	First level Idle boost request cancelled
Idle Boost 2 Start	-	-	Battery has a net loss greater than 1.6 AH	Second level Idle boost requested
Idle Boost 2 Start	-	Less Than 10.9 V	-	Second level Idle boost requested
Idle Boost 2 End	-	Greater Than 12 V	Battery has a net loss less than 0.8 AH	Second level Idle boost request cancelled
Idle Boost 3 Start	-	-	Battery has a net loss of 10.0 AH	Third level Idle boost requested
Idle Boost 3 Start	-	Less Than 10.9 V	-	Third level Idle boost requested
Idle Boost 3 End	-	Greater Than 12 V	Battery has a net loss of less than 6 AH	Third level Idle boost request cancelled

STARTING SYSTEM DESCRIPTION AND OPERATION

The starter motors on this vehicle are non-repairable. They has pole pieces that are arranged around the armature. Both solenoid windings are energized. The pull-in winding circuit is completed to the ground through the starter motor. The windings work together magnetically to pull and hold in the plunger. The plunger moves the shift lever. This action causes the starter

drive assembly to rotate on the armature shaft spline as it engages with the flywheel ring gear on the engine. Moving at the same time, the plunger also closes the solenoid switch contacts in the starter solenoid. Full battery voltage is applied directly to the starter motor and it cranks the engine.

As soon as the solenoid switch contacts close, current stops flowing thorough the pull-in winding because battery voltage is applied to both ends of the windings. The hold-in winding remains energized; its magnetic field is strong enough to hold the plunger, shift lever, starter drive assembly and solenoid switch contacts in place to continue cranking the engine. When the engine starts, pinion overrun protects the armature from excessive speed until the switch is opened.

When the powertrain control module (PCM)/engine control module (ECM) sees an engine run flag, the ground on the 3.8L or 12 volts on the 4.6L is removed from the control circuit of the Starter relay. The switch side of the Starter relay opens and battery voltage is removed from the starter solenoid S terminal. Current flows from the motor contacts through both windings to the ground at the end of the hold-in winding. However, the direction of the current flow through the pull-in winding is now opposite the direction of the current flow when the winding was first energized.

The magnetic fields of the pull-in and hold-in windings now oppose one another. This action of the windings, along with the help of the return spring, causes the starter drive assembly to disengage and the solenoid switch contacts to open simultaneously. As soon as the contacts open, the starter circuit is turned OFF.

Circuit Description 4.6L

When the ignition switch is placed in the Start position, a discrete signal is supplied to the body control module (BCM) notifying it that the ignition is in the Start position. The BCM then sends a message to the engine control module (ECM) notifying it that CRANK has been requested. The ECM verifies that the transmission is in Park or Neutral. If it is, the ECM then supplies 12 volts to the control circuit of the crank relay. When this occurs, battery positive voltage is supplied through the switch side of the crank relay to the S terminal of the starter solenoid.

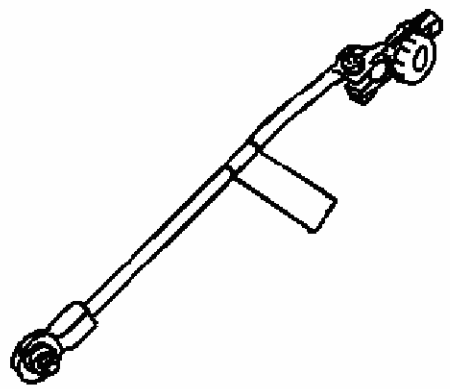
Circuit Description 3.8L

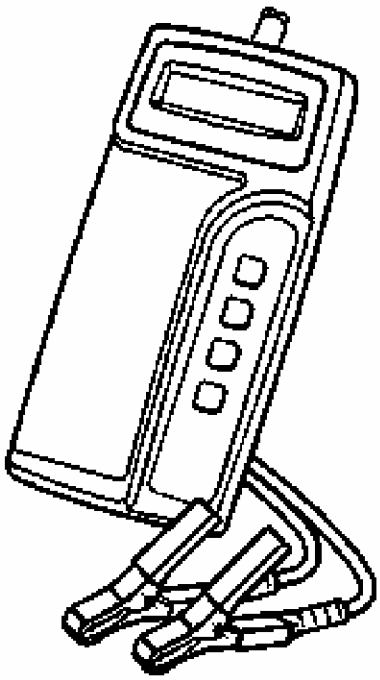
When the ignition switch is placed in the Start position, a discrete signal is supplied to the body control module (BCM) notifying it that the ignition is in the Start position. The BCM then sends a message to the powertrain control module (PCM) notifying it that CRANK has been requested. The PCM verifies that the transmission is in Park or Neutral. If it is, the PCM then supplies a ground to the control circuit of the crank relay. When this occurs, battery positive voltage is supplied through the switch side of the crank relay to the S terminal of the starter solenoid.

SPECIAL TOOLS AND EQUIPMENT

SPECIAL TOOLS

Special Tools

Illustration	Tool Number/Description
	J 38758 Parasitic Draw Test Switch
	J 42000 Battery Tester



2006 Buick Lucerne CXS

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